REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART I.

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INTRODUCTION.

The Mediterranean Fever Commission had its origin in a letter from Mr. Secretary Lyttelton, dated January 25, 1904, addressed to the Royal Society, in which he states that his attention has recently been called to the prevalence of Mediterranean fever in Malta among the Naval and Military forces, as well as the civil population.

It accordingly appeared to him to be desirable that the investigation of this fever should be taken in hand, and he addressed a despatch to the Governor of Malta proposing the appointment of a joint Commission representing the Army, the Navy, and the Civil Government.

He enclosed a copy of a despatch from the Governor in reply, entirely concurring in the proposed appointment of a joint Commission. The War Office and Admiralty also expressed their concurrence in the proposal.

Mr. Secretary Lyttelton then went on to say that the War Office, the Admiralty, and the Civil Government desired to secure for this Commission the assistance of the Royal Society, and asked whether the Society would be willing to appoint an Advisory Board of experts in this country for the purpose of supervising the investigations.

In reply to this letter the Royal Society wrote, in February, 1904, consenting to nominate a Committee to direct the investigations, on the understanding that the selection of the investigators should be placed in the hands of the Royal Society.

A Sub-Committee of the Tropical Diseases Committee was accordingly formed, consisting of Colonel Bruce, R.A.M.C., Chairman, Fleet Surgeon Bassett-Smith, R.N., Dr. Klein, Dr. C. J. Martin, and Dr. Sidney Martin.

As it was desirable to begin the investigations with as little delay as possible, the Sub-Committee at once appointed Major Horrocks, R.A.M.C., Staff-Surgeon Shaw, R.N., and Dr. Zammit, Board of Health, Malta, as members of the Commission, and Colonel Bruce was requested to proceed to Malta to assist them in commencing the work. Colonel Bruce arrived in Malta on June 13, where he met the Commission, and work was at once begun. He remained in Malta until July 14, when he left for England. Dr. Johnstone, whose services were lent by the Local Government Board, on the application of the Royal Society, joined the Commission on June 30.

The best thanks of the Commission are due to the Governor, General Sir C. M. Clarke, G.C.B., and to the Lieutenant-Governor, the Hon. E. M. Merewether, C.M.G., for their courtesy and invaluable aid.

The following reports have been received, up to the present date, from the members of the Commission, and also one from Staff-Surgeon Gilmour, R.N., Bighi Hospital, Malta, who kindly placed his spare time at the service of the Commission.

1.

ON THE DURATION OF LIFE OF THE *MICROCOCCUS MELITENSIS* OUTSIDE THE HUMAN BODY.

(Experiments made at Gibraltar.)

By Major W. H. HORROCKS, R.A.M.C., Member of Mediterranean Fever Commission.

(Received July 14, 1904.)

The small size and slow growth of the *Micrococcus melitensis* render the study of its saprophytic existence by no means an easy matter. In the hope of devising a medium which would simplify the isolation of the Micrococcus from a mixture of microbes, a careful study of its cultural characteristics on all modern media of an exact reaction was first made. It was thought that the degree of fermentation or non-fermentation of the various sugars might assist in attaining the desired differentiation. The results of the tests are shown in the following table :—

Cultural Characteristics.

Glucose peptone, 1 per cent. . . .	Growth. Neither acid nor gas produced.
Lactose peptone, „ . . .	„ „ „
Saccharose peptone, 1 per cent.	„ „ „
Starch peptone, 1 per cent.	„ „ „
Litmus milk.	No clotting observed; at the end of 3 weeks the medium was found to have a distinctly alkaline reaction.
Peptone and salt solution.	On the addition of a nitrite and pure sulphuric acid, the nitroso-indol reaction was never obtained.
Broth	Diffuse growth without any surface pellicle. After some days the broth cleared somewhat, and a deposit formed on the sides and at the bottom of the tube.
Agar slope	Greyish-white moist growth; discrete colonies, circular and transparent, resembling those of the Gram-staining streptococci found in fæces and urine. When the cultures are old, the growth often acquires a yellowish-brown colour.

Proskauer and Capaldi's media	No. I. No growth. No. II. Growth, but no change appeared in the reaction of the medium.
Neutral red	Unchanged after 48 hours at 37° C.; after 5 days' incubation a yellow colour appeared at the surface.
Potato	Moist transparent film appeared, and on scraping the surface a copious growth was obtained, the formation of chains being very marked. The reaction of the potato was made faintly alkaline by the addition of sodium carbonate, and on planting out on the surface a distinct yellowish coloured growth was obtained.
MacConkey's bile salt broth ...	Growth; reaction unchanged.
Nitrate broth	Growth, but no reduction of the nitrates occurred.
Gelatine stab and slope (22° C.)	Growth extremely slow; no liquefaction of the medium.
Agar stab (37° C)	Diffuse growth.
Anaërobiosis	Growth, but more feeble than under aërobic conditions.
Morphology	Very small cocci, appearing as diplococci and short chains; occasionally chains of twelve to fourteen cocci were observed.

The failure of the *M. melitensis* to ferment glucose, and its power of rendering milk alkaline are very important cultural reactions. The Gram-staining streptococci, isolated from sewage, urine, fæces, cases of erysipelas, and from septic throats, all ferment glucose; the amount of acid produced, however, is a variable quantity. In glucose agar media, tinted with litmus, the Gram-staining streptococci produce colonies varying in tint from a rose red to a bright red, but the colonies of the *M. melitensis* are always blue, and after a few days' incubation the colour deepens in tint.

The gelatine, broth, agar, and peptone media, were made with a reaction of + 10 (Eyre's scale), and as a rule distinct growth was not observed until the 2nd or 3rd day after planting out, incubation being at 37° C.

Several observers having stated that the *M. melitensis* grew best on media having an alkaline reaction; batches were prepared having reactions: − 15, − 10, neutral, + 10, + 15 (Eyre's scale). Approximately, the same amount of culture was planted out, and it was found that the quickest and most copious growth was obtained on the + 10 medium; on the − 10 and − 15 there was practically no growth.

Having determined the most favourable reaction, trials were made to see if a medium could not be obtained on which the *M. melitensis* would grow in 24 hours. Bearing in mind the favourable effect of nutrose on the growth of *B. typhosus*, a 1-per-cent. nutrose agar, + 10,

was prepared, and on this a marked growth of *M. melitensis* occurred in 16 hours. A similar vigorous growth was obtained in nutrose broth.

The study of the cultural reactions having shown that the *M. melitensis* did not ferment glucose, it appeared that the addition of this sugar to the nutrose medium, tinted with litmus, would be of great service when isolating the organism from a mixed culture. As previously stated, the Gram-staining streptococci, which occur in urine and fæces, ferment glucose, forming enough acid to change the blue medium to a rose tint, and as the colonies of these organisms have much the same transparent appearance as those of *M. melitensis* on nutrose agar, the use of the glucose litmus medium enables a separation to be readily made, and saves much time when investigating plate cultures.

Trials were then made with the *M. melitensis* added to non-sterile water and soil, and it was found that the organism could be readily isolated when it was present in considerable quantity; when, however, only a few cocci were present, there was a marked tendency for the water and soil organisms to grow over the plate, the nutrose evidently accelerating the growth of these organisms. Accordingly, attempts were made to restrain the growth of these organisms by the addition of sodium taurocholate, carbolic acid, malachite green, etc.

A medium containing 0·5 per cent. sodium taurocholate, 1 per cent. peptone and 0·5 per cent. salt was prepared, and the tubes inoculated with *M. melitensis*, urine, soil, and water respectively. The results are shown in the following table:—

	24 hours.	48 hours.	72 hours.	96 hours.
Tube 1. *M. melitensis*	±	±	+	+
Tube 2. One loop urine	±	±	+	+
Tube 3. One loop of soil	±	±	+	+

Note.—±, feeble growth; +, good growth; −, no growth.

The growth which appeared in Tube 1, after 48 hours' incubation, was planted out on nutrose agar, and the *M. melitensis* recovered after 3 days' incubation at 37° C.

This experiment showed that, while the sodium taurocholate restrained the growth of the microbes in soil and urine, it had also a marked inhibiting effect on the growth of the *M. melitensis*.

The addition of nutrose to the taurocholate medium was then tried, with the following result:—

	24 hours.	48 hours.	72 hours.
Tube 1. *M. melitensis*	±	+	+
Tube 2. One loop of urine ...	+	+	+ +
Tube 3. One loop of soil	±	+	+

The growth in Tube 1, which appeared in 48 hours, was planted out on nutrose agar, and the *M. melitensis* recovered after 48 hours' incubation at 37° C.

The addition of the nutrose caused a more vigorous growth of the *M melitensis*, but unfortunately the growth of the bacteria in urine was enhanced more than that of the *M. melitensis.* The results with these media when grown at 37° C. being unsatisfactory, the temperature of incubation was raised to 42° C. in the hope that it might cause a more satisfactory separation. Hughes, in his book on Mediterranean fever, stated that the *M. melitensis* would not grow at 42° C., so a preliminary planting out on ordinary agar and nutrose agar was tried. The results were as follows :—

	24 hours.	48 hours.	72 hours.	96 hours.	5 days.
Ordinary agar (+10)	–	–	–	±	±
Nutrose agar (+10)	±	±	±	+	+

Temperature of incubation, 42° C.

On ordinary agar the growth was much delayed and feeble at the end of 5 days, but on nutrose agar a good growth was obtained after 72 hours.

Nutrose, sodium taurocholate peptone tubes were now inoculated with soil, urine, tap-water and *M. melitensis.* Incubation 42° C.

	24 hours.	48 hours.	72 hours.	96 hours.
Tube 1. One c.c. tap-water ..	–	±	±	+
Tube 2. One loop soil	–	±	+	+ +
Tube 3. One of urine	±	+	+	+ +
Tube 4. One of *M. melitensis* .	±	±	±	+

The results were again disappointing; the method would be of very little use in regard to urine investigation, but might render some assistance when working with inoculated water supplies.

Malachite green, krystal violet, etc., being credited with the power of restraining the growth of saprophytes, the former salt was selected for experiment.

The powder was dissolved in distilled water and the solution added to + 10 broth, so as to make dilutions of 0·01 per 1,000, 0·02 per 1,000, 0·05 per 1,000, 0·1 per 1,000, and 0·2 per 1,000. The tubes were incubated at 37° C. for 24 hours, and remaining quite sterile were each inoculated with one loopful of an emulsion of *M. melitensis.* After 24 hours' incubation at 37° C., it was found that there was a good growth of *M. melitensis* in all the tubes except the 0·2 per 1,000. Similar dilutions were then inoculated with urine and soil—the tube containing 0·1 per 1,000 was found to have a marked restraining influence on the growth of the bacteria for a period of 24 hours; but after 48 hours' incubation there was a rapid growth of the bacteria in urine.

Nutrose was then added to the malachite green solution, so that the medium now contained 1 per cent. of nutrose and 0·1 per 1,000 of malachite green.

The tubes were inoculated with an emulsion and incubated at 37° C. After 24 hours it was found that there was a vigorous growth of the *M. melitensis*, but unfortunately, as in the case of the sodium taurocholate, the bacteria in the urine and soil also showed a marked growth. Consequently, it was decided to omit the nutrose from the malachite green broth during the preliminary investigations. A non-sterilised garden soil was inoculated with *M. melitensis* and then planted out in malachite green broth; after 24 hours' incubation at 37° C. a feeble growth occurred, which was stroked over the surface of a series of Petri dishes containing nutrose agar. The plates were incubated at 37° C.; after 24 hours there was practically no growth, but after 48 hours there was a marked growth, and the transparent colonies of the *M. melitensis* were easily detected scattered amongst the larger and opaque colonies produced by the soil organisms. This result was satisfactory, and the procedure appears likely to give useful results.

Carbolic acid was next tried; it was found that the *M. melitensis* grew well in 24 hours in 0·05 per cent. carbolic broth, but this small amount of acid has a very slight restraining influence on the growth of the bacteria in urine and soil, and consequently the *M. melitensis* was always crowded out by the saprophytic bacteria. The amount of carbolic acid was increased to 0·1 per cent., but in this the *M. melitensis* did not appear for 4 days, whereas the saprophytic organism grew vigorously in 48 hours. Accordingly, carbolised media were abandoned during the research.

Exposure to a temperature of 42° C., and the presence of malachite green, carbolic acid and sodium taurocholate, having failed to restrain the growth of bacteria present in urine obtained from Malta fever

patients after careful sterilisation of the external parts, growth under anaërobic conditions was tried but with equally unsatisfactory results. It now appeared evident that in the study of urine all restraining influences must be abandoned and efforts made to obtain as free a growth of the microbes as possible, trusting to subsequent dilution to obtain isolated colonies for purposes of study. Experimentally, this procedure succeeded well enough when the Micrococcus was added in considerable quantity to urine, but when the amount inoculated was small, isolation of the Micrococcus could not be effected. Trials were then made as to the effect of adding a strong specific serum to these latter growths; it was thought that the serum might cause the aggregation of the Micrococci into clumps, and if these were planted out on agar plates a better chance of success might be obtained. The results were encouraging, and in future examinations of the urine of Malta fever cases, it is intended to follow this procedure, as well as the usual dilution method on agar plates.

Experiment I.

An investigation was now undertaken to ascertain whether the *M. melitensis* could live in urine, and especially in a urine which had become alkaline from the decomposition of urea.

A freshly passed urine from a healthy man was inoculated with an emulsion of *M. melitensis* made in distilled water from a recent agar slope. The urine when passed appeared practically sterile. The inoculated urine was placed in a laboratory cupboard and examined daily by plating on nutrose agar. The Micrococcus was easily recovered up to and on the 6th day, but could not be detected at a later period. The urine on the 6th day was markedly alkaline from the presence of ammonia, and on titrating it with N/10 acid, the ammonia was found to equal 0·0064 gramme NH_3 per c.c.

This result is of some practical importance as it shows that the *M. melitensis* might be recovered from a urine which had been kept for 6 days and become alkaline in reaction.

The viability of the *M. melitensis* in the presence of ammonia and the comparative absence of saprophytic microbes from the urine in the experiment just related, suggested that, perhaps, this alkali might have a restraining influence on the growth of the bacteria usually found in the urine of Mediterranean fever cases, and so assist in the separation of the specific microbe. Accordingly, broth (+ 10) was treated with pure NH_3 until the amount when titrated with N/10 acid equalled 0·64 gramme per litre. The tubes were incubated and remaining sterile, were then inoculated with *M. melitensis* and with urine from a case of Mediterranean fever. After 24 hours' incubation there was a marked growth of bacteria in the tubes inoculated with urine, but the *M. melitensis* did not show any marked growth until the 4th day. The

result was not unexpected as the work previously done on the reaction of media had shown that the *M. melitensis* did not grow well in alkaline media.

Experiment II.

This experiment was designed in order to ascertain the duration of life of *M. melitensis* when maintained in an absolutely dry state and without a trace of nutrient medium.

A series of sterile cover glasses were placed in a Petri dish and then inoculated with an equal quantity of an emulsion of *M. melitensis*, the cocci from a 48 hours' agar slope being suspended in water. The emulsion was exposed to the air until all traces of moisture had disappeared from the cover glasses. The Petri dish was then placed in a laboratory cupboard, the temperature of which averaged 18° C. Every 24 hours a cover slip was removed and planted out in broth. The resulting growth was plated on agar, and the colonies fished and examined in the following manner :—A likely colony was made into an emulsion with a loopful of broth and then examined under $\frac{1}{12}$th objective ; if cocci were found freely disseminated through the field and showing no signs of clumping, a loopful of serum from an inoculated rabbit was added. When clumping occurred the needle, which had been used to make the emulsion and *not* sterilised, was rubbed over an agar slope. The resulting growth was planted out in glucose peptone, lactose peptone, cane sugar peptone, litmus milk, peptone and salt solution, nitrate broth, and stabbed into gelatine. The growths which resulted corresponded exactly to those obtained when the original *M. melitensis* was planted out in these media.

Result.—A Micrococcus, which corresponded in every particular to the *M. melitensis*, was isolated up to and on the 16th day.

Experiment III.

The object of this experiment was to ascertain the duration of the life of *M. melitensis* in dry soil.

Some soil from a recently manured plot of ground in Gibraltar was powdered, dried, and sterilised, and then inoculated with an aqueous emulsion of *M. melitensis* prepared from an agar slope. The soil was allowed to dry naturally and kept in the laboratory cupboard mentioned in the previous experiment. For a few days traces of moisture were present, but after the 10th day the soil was quite light and formed a black powder which could easily be blown about. The soil was tested weekly for the presence of *M. melitensis*, a portion of the soil being planted out in broth and the resulting growth treated in the manner detailed under Experiment II. Up to and on the 69th day a Micrococcus was recovered, corresponding in every way to the *M. melitensis* originally planted out. During this experiment

careful watch was kept for any change in the morphology of the inoculated microbe. It was thought that the bacillary forms described by Durham might appear, and cause some difficulty in diagnosing the culture. The bacillary forms were never seen, and the Micrococcus obtained on an agar slope on the 69th day presented the usual morphology. The cultural characteristics and reaction to the specific serum were also unchanged.

Result.—The *M. melitensis* retained its vitality in dry soil for 69 days.

Experiment IV.

In this experiment a fine sterile sand, practically free from organic matter, was inoculated, and treated in exactly the same manner as the manured soil in Experiment III. The *M. melitensis* was recovered up to and on the 20th day, but not later. The morphology, cultural and serum reactions, were again quite unchanged.

Result.—The *M. melitensis* retained its vitality in dry sand for 20 days.

Experiment V.

The object of this experiment was to discover the duration of life in a foul soil saturated with water. The manured sterile soil employed in Experiment III was inoculated in the same manner as before, but instead of being allowed to dry it was kept saturated with sterile tap-water. The *M. melitensis* was recovered up to and on the 7th day, but could not be detected at a later date, although many trials were made. The result of this experiment seemed to show that immersion in water was inimical to the persistence of the *M. melitensis* in a saprophytic condition.

Result.—The *M. melitensis* retained its vitality in a foul, saturated soil for 7 days.

Experiment VI.

The idea of this experiment was to ascertain the duration of life of the *M. melitensis* when dried on fabrics. Accordingly, pieces of thick regulation blanket, khaki serge, and khaki cotton were inoculated with an emulsion of the microbe made by suspending a recent agar growth in sterile water. The greatest care was taken not to remove any of the nutrient medium. After inoculation the infected fabrics were placed in a Petri dish and allowed to dry naturally; they were then placed in the laboratory cupboard during the whole experiment. Portions of the fabrics were planted out in broth every 3 or 4 days, and the resulting growth plated on nutrose agar in the usual manner. The *M. melitensis* was recovered from the khaki cotton up to and on the 80th day, from the khaki serge on the 80th day, and from the blanket on the 80th day. The morphology, cultural and serum reactions, were again quite unchanged.

Experiment VII.

The rapid disappearance of the *M. melitensis* from the soil saturated with water suggested that an attempt should be made to determine the duration of life of the *M. melitensis* in sterile water. The whole of a recent growth from an agar slope was diffused in 50 c.c. of sterile tap-water, representing an exceedingly gross pollution. The flask was kept in the laboratory cupboard, and every day 1 c.c. was plated on nutrose agar. The Micrococcus was readily isolated for 6 days, but on the 7th and 13th days it could not be detected.

Experiment VIII.

This experiment was a repetition of Experiment VII, but instead of planting out small quantities from day to day, the flask was left undisturbed for 3 weeks. Broth was then added so as to enrich the whole bulk of the water, and the flask incubated at 37° C. for 3 days. The growth which resulted was found to contain numerous small cocci decolorised by Gram's method. A portion of the growth was then added to an equal quantity of a strong rabbit serum diluted 1—10, and the whole thoroughly mixed was drawn up into a capillary pipette. Distinct agglutination having occurred, the pipette was then opened and the agglutinated mass stroked over a series of agar plates; unfortunately a pure culture of the *M. melitensis* was not obtained. The result of this experiment is not conclusive, but it suggests that the duration of life of the *M. melitensis* in water may be longer than 1 week.

Conclusions.

(1) The *M. melitensis* is able to live for 6 days in a urine which has become alkaline from the presence of ammonia.

(2) The *M. melitensis* survives for 16 days when spread in a thin layer on a glass cover slip.

(3) The *M. melitensis* survives for 69 days when planted in a dry sterilised manured soil.

(4) In dry sterilised sand the duration of life of the *M. melitensis* appears to be only 20 days.

(5) In a sterilised manured soil saturated with water the *M. melitensis* appears to survive for only 7 days.

(6) The *M. melitensis* is able to live for 80 days on dry fabrics, such as blanket, khaki serge, and khaki cotton.

(7) The *M. melitensis* appears to live for a comparatively short time in sterilised tap-water. It was only recovered in pure culture 6 days after being planted out, though from the result of Experiment VIII it appears possible that the duration of life may extend to 3 weeks.

2.

FURTHER STUDIES ON THE SAPROPHYTIC EXISTENCE OF *MICROCOCCUS MELITENSIS.*

By Major W. H. Horrocks, R.A.M.C., Member Mediterranean Fever Commission.

(Received September 17, 1904.)

1. Duration of Life of the *M. melitensis* in Sterilised Tap-Water.

Experiment I.

In the Gibraltar report it was stated that the duration of life of the *M. melitensis* in sterilised tap-water was probably longer than the recorded experiments indicated. Accordingly, the experiment of adding an emulsion of *M. melitensis*, made by carefully mixing the growth from an agar slope in sterile water to a known volume of water, was repeated. In this case 1 c.c. of an emulsion made from a strain of *M. melitensis* isolated from urine was added to 10 c.c. of sterilised tap-water. Chemical analysis showed that the tap-water was very pure, and contained practically no organic material. The emulsion was added to the tap-water on August 1, 1904, and at various times 0·5 c.c. was removed, and added to 10 c.c. of broth, the contents of the tube being thoroughly mixed and then incubated at 37° C. As soon as the broth tube showed any signs of growth a large loopful was stroked in a zig-zag manner over an agar slope, which was then incubated at 37° C. On August 15, 1904, a pure culture of *M. melitensis* was isolated, the growth responded to all the usual cultural tests, and agglutinated at once with the serum of Monkey 45, diluted 1—1000. On August 21, 1904, the same procedure was followed, and the *M. melitensis* again isolated. On August 27, 1904, a pure culture of *M. melitensis* was obtained, and appeared quite unchanged. On September 6, 1904, the specific microbe was again isolated.

Result.—The *M. melitensis*, derived from urine, appears to survive for 37 days in sterilised tap-water.

2. Duration of Life of the *M. melitensis* when Planted out in Soil.

In the Gibraltar experiments already recorded a manured garden soil and a dry sand were employed. Valletta and Sliema are mainly built on the Globigerina limestone, and the white dust which abounds on the roads is chiefly due to the attrition of this stone; occasionally the soil has a red colour, due to the presence of oxide of iron resulting from the oxidation of FeS_2 (iron pyrites).

Experiment II.

A grey coloured soil was obtained from Sliema, and ground into a fine powder. According to Sir John Murray's analysis, this soil has the following composition:—

Carbonate of lime, iron, and alumina ($CaCO_3$,Fe_2O_3,Al_2O_3)	78·39
Phosphate of lime (Ca_32PO_4)	2·70
Magnesium carbonate ($MgCO_3$)	0·44
Calcium sulphate ($CaSO_4$)	0·33
Insoluble in dilute HCl (1—10)	17·87
	99·73

The soil was carefully dried and sterilised, and a portion planted out in broth and incubated at 37° C. After 4 days' incubation there were no signs of growth, showing that sterilisation had been effected. On July 15, 1904, the soil was inoculated with an emulsion of *M. melitensis*, made by suspending the growth on an agar slope in distilled water, and allowed to dry naturally. On July 23, 1904, a portion of the soil, still showing faint traces of moisture, was planted out in broth and incubated at 37° C. On July 26, 1904, a growth occurred in the broth culture, which was planted out on an agar slope; two days later a typical growth, which responded to all the characteristic tests, appeared. On July 30, 1904, the soil was noted to be practically dry. On August 11, 1904, a portion of the soil was removed and treated in the same manner as on July 23, 1904; a typical growth of the *M. melitensis* was again obtained. On August 19, 1904, the same procedure was followed, and a pure culture of the specific microbe was isolated. On August 27, 1904, the *M. melitensis* was again isolated.

Result.—The *M. melitensis* survived for 43 days in a soil, which was allowed to dry naturally, and which was free from appreciable traces of moisture for 27 days.

Experiment III.

In this experiment a reddish coloured soil, also obtained from Sliema, was employed. Sir John Murray's analysis of this soil gave the following results:—

Carbonate of lime ($CaCO_3$)	80·24
Phosphate of lime (Ca_32PO_4)	3·57
Magnesium carbonate ($MgCO_3$)	1·63
Calcium sulphate ($CaSO_4$)	0·06
Iron and alumina (Fe_2O_3 and Al_2O_3)	1·13
Insoluble in dilute HCl (1 in 10)	12·88
	99·51

The soil was sterilised, and its sterility tested as in Experiment I. On June 25, 1904, it was inoculated with an emulsion of *M. melitensis*, made in sterile water from an agar slope grown for 48 hours at 37° C. The soil, having been dried in the incubator at 37° C., was placed in the laboratory cupboard. On July 4, 1904, a portion of the soil was planted out in broth, and the growth which resulted on July 7, 1904, was planted out on an agar slope. A typical culture, giving all the reactions of the *M. melitensis*, was obtained.

On July 11, 1904, the soil was again tested, and a pure culture of *M. melitensis* was isolated.

On July 15, 1904, an examination was made, but the growth in broth did not take place for 9 days, showing that the organism was much enfeebled. On planting out the growth on agar only a few colonies of the *M. melitensis* were obtained. On July 24, 1904, and on July 30, 1904, examinations were made, but the results were negative, the *M. melitensis* having apparently died out.

Result.—The *M. melitensis* lived for 21 days in red Sliema soil, thoroughly dried immediately after inoculation.

Experiments IV and V.

These experiments were designed in order to ascertain whether the presence of traces of moisture, as distinguished from flooding of the soil, had any influence on the survival of the *M. melitensis.*

In Experiment IV white Globigerina limestone dust was inoculated with *M. melitensis* on July 8, 1904; the tube was then placed in the laboratory cupboard. About once a week a little sterile tap-water was added by means of a pipette, so as to preserve a faint appearance of moisture on the surface of the soil. At various intervals portions of the soil were removed and planted out in broth, the tube being then incubated at 37° C. The resulting growth was planted on agar and tested as already described under Experiment I.

The *Micrococcus melitensis* was isolated on July 15, 1904.
„ „ „ July 24, 1904.
„ „ „ July 30, 1904.
„ „ „ August 11, 1904.
„ „ „ August 19, 1904.

The Micrococcus melitensis was isolated on August 27, 1904.
" " " September 7, 1904.
" " " September 19, 1904.

Result.—The *M. melitensis* survived for 72 days in a damp soil.

In Experiment V the red soil, described under Experiment II, was employed. The soil was inoculated on July 8, 1904, and the testings carried out at the same time as in Experiment III. The *M. melitensis* was isolated after 72 days' immersion in this soil.

3. Survival of the *M. melitensis* after Exposure to the Sun.

Experiment VI.—Exposure on Thin Strips of Glass.

A 36-hours' growth of *M. melitensis* on nutrose agar was made into an emulsion with sterile tap-water. A series of thin glass cover slips were sterilised and the surface of each inoculated with the emulsion by means of a sterile pipette. The cover slips were then exposed to the sun as follows :—

On June 17, 1904, from 9.30 A.M. to 11 A.M. Maximum temperature in the sun, 130° F. (54°·4 C.).

On June 17, 1904, from 3.10 P.M. to 4.10 P.M. Maximum temperature in the sun, 130° F. (54°·4 C.).

On June 19, 1904, from 10.15 A.M. to 12.15 P.M. Maximum temperature in the sun, 133° F. (56°1 C.).

After each exposure one of the cover slips was added to sterile broth and incubated at 37° C. The broth tubes all remained sterile, though the incubation was maintained for 14 days.

From control slips, not exposed to the sun, the *M. melitensis* was easily recovered.

Experiment VII.—Exposure in a Very Thin Layer of Soil.

Samples of white and red soils, already mentioned under the soil experiments, were spread in layers, $\frac{1}{8}$ inch deep, on the bottom of glass dishes, and then inoculated with an emulsion of *M. melitensis*, made from an agar slope as mentioned above. The dishes were exposed to the sun as follows :—

On June 20, 1904, from 12.15 P.M. to 1 P.M. Maximum temperature in the sun, 128° F. (53°·3 C.).

On June 21, 1904, from 8.50 A.M. to 11.50 A.M. Maximum temperature in the sun, 135° F. (57°·2 C.).

On June 22, 1904, from 8.45 A.M. to 11.45 A.M. Maximum temperature in the sun, 126° F. (52°·2 C.).

On July 1, 1904, from 10.30 A.M. to 12.30 P.M. Maximum temperature in the sun, 133° F. (56°·1 C.).

After eaeh cxperiment particles from the dried baked surface were planted out in broth, and any resulting growth was then planted out on agar and the growth tested for agglutination, etc. The *M. melitensis* was recovered after the exposure on June 21, 1904, representing $3\frac{3}{4}$ hours' exposure to direct sunlight, but not later.

The *M. melitensis* was readily obtained from a control soil after 21 days in the laboratory cupboard.

Experiment VIII.—Exposure on Khaki Drill.

A piece of khaki drill was inoculated with the same emulsion used in the previous experiments. The drill was then exposed to the sun as follows:—

On June 17, 1904, from 9.30 A.M. to 11 A.M. Maximum temperature in the sun, 130° F. (54°·4 C.).

On June 17, 1904, from 3.10 P.M. to 4.10 P.M. Maximum temperature in the sun 130° F. (54°·4 C.).

On June 19, 1904, from 10.15 A.M. to 12.15 P.M. Maximum temperature in the sun, 133° F. (56°·1 C.).

After each exposure a portion of the infected drill was cut off and planted out in broth, and the resulting growth planted out on agar and tested in the usual manner.

The *M. melitensis* was recovered after an exposure of not more than $2\frac{1}{2}$ hours to the sun.

Experiment IX.—Exposure on Soil $\frac{1}{2}$-inch Deep.

The idea of this experiment was to ascertain whether the deeper layers of the soil, which were quite dry and capable of being blown about by strong winds, would still retain infection after exposure to the sun.

The white Globigerina limestone soil, previously described, was sterilised and carefully poured into a sterile Petri dish so as to form a uniform layer $\frac{1}{2}$ inch deep. The soil was then inoculated with an emulsion of *M. melitensis*, made by suspending the growth on an agar slope, inoculated from a urine culture and incubated for 48 hours at 37° C. The soil was exposed to the sun as follows:—

August 19, 1904, 3.30 P.M. to 4.30 P.M. Maximum temperature in the sun, 147° F. (63°·8 C.).

August 20, 1904, 9 A.M. to 11.45 A.M. Maximum temperature in the sun, 153° F. (67°·2 C.). After the total exposure of $3\frac{3}{4}$ hours, a portion from the surface was planted out in broth, so as to compare this experiment with the one previously reported.

August 21, 1904, exposed from 9.30 A.M. to 11.30 A.M. Maximum temperature in sun, 154° F. (67°·7 C.). After a total exposure of

5¾ hours, portions of soil taken from the surface and from the depth were planted out in broth tubes.

August 22, 1904, exposed from 9 A.M. to 11.15 A.M. Maximum temperature in sun 148° F. (64°·4 C.). Portions of soil from the surface and depth again planted out in broth.

August 23, 1904, exposed from 10.15 A.M. to 11.15 A.M. Maximum temperature in the sun, 148° F. (64°·4 C.). Planted out portions of soil from the surface and depth in broth tubes.

August 25, 1904, exposed from 10.15 A.M. to 11.15 A.M. Maximum temperature in the sun, 146° F. (63°·3 C.). Total exposure since the 19th equals 10 hours. Planted out portions of soil from the surface and depth in broth tubes.

September 6, 1904. All the broth tubes which had been incubated at 37° C., since the date of inoculation, were planted out on agar slopes.

September 12, 1904. All the agar tubes inoculated with the broth containing the surface soil, have remained quite sterile.

September 12, 1904. The agar tubes inoculated with the broth containing the portions of soil taken from the depth after 5¾ and 8 hours' exposure, show a growth of *B. mesentericus.* There is no sign of the *M. melitensis.*

The agar tubes inoculated with the broth tubes containing the soil from the depth after 9 and 10 hours' exposure are quite sterile.

Result.—The heat derived from exposure to the sun, the maximum temperature varying between 146° F. and 153° F., apparently destroys the *M. melitensis* at a depth of ½ inch from the surface.

Experiment X.—Duration of Life of the M. melitensis *when Planted out in Sea-Water.*

Sea-water was obtained from the harbour and sterilised. A portion was then planted out on agar and in broth; both the tubes remained sterile after incubation at 37° C.

On July 25, 1904, a tube containing 10 c.c. of sterile sea-water was inoculated with the growth obtained from an agar slope, incubated for 13 days at 37° C. The inoculated tube was placed in the laboratory cupboard. On July 29, 1904, 0·5 c.c. was removed from the tube and planted out in broth; on September 2, 1904, there was a distinct growth in the broth; the growth was planted out on an agar slope, and a typical growth of *M. melitensis* was obtained, which responded to the classical tests.

On July 31, 1904, 0·5 c.c. was planted out in broth, and the same procedure followed as on July 29, 1904; a typical growth of *M. melitensis* was obtained.

On August 5, 1904, 0·5 c.c. was planted out in broth; a growth of *M. melitensis* resulted.

On August 8, 1904, 0·5 c.c. was planted out as before, and a pure culture of *M. melitensis* was obtained.

On August 12, 1904, 0·5 c.c. was planted out in broth; the resulting growth when planted on an agar slope gave rise to a growth, which agglutinated very slowly with the serum from Monkey 45. A portion of the growth was planted out in glucose and litmus milk; the glucose was not fermented, and the litmus milk became alkaline, without showing the slightest trace of coagulation or digestion. The growth also had a typical morphology, and did not stain by Gram's method.

On August 15, 1904, 0·5 c.c. was planted out in broth, and a culture again obtained, which was typical of *M. melitensis*, except that the agglutination occurred slowly.

On August 19, 1904, 0·5 c.c. was planted out, and the same result obtained as on August 12 and 15, 1904. The growth was tested with the specific serum which, diluted 1—1000, caused instantaneous agglutination of the laboratory standard culture of *M. melitensis*. With the growth from sea-water, this serum, diluted 1—1000, caused clumping in ½ hour.

On August 22, 1904, 0·5 c.c. was planted out in broth, and incubated at 37° C. No sign of growth appeared after 15 days' incubation.

On August 26, 1904, 0·5 c.c. was again planted out, but no growth appeared.

Result.—The *M. melitensis* appears to survive for 25 days in sterilised sea-water.

Conclusions.—1. The *M. melitensis* retains its vitality in sterilised tap-water for 37 days.

2. In a Maltese soil, allowed to dry naturally, the *M. melitensis* survives for 43 days; and in one thoroughly dried immediately after inoculation, it survives for 21 days.

3. The *M. melitensis* survives for 72 days in a damp soil.

4. Exposure to the sun for a few hours kills the *M. melitensis*.

5. The *M. melitensis* survives for 25 days in sterilised sea-water.

3.

ON THE RECOVERY OF THE *MICROCOCCUS MELITENSIS* FROM THE URINE, FÆCES, AND SWEAT OF PATIENTS SUFFERING FROM MEDITERRANEAN FEVER.

By Major W. H. Horrocks, R.A.M.C., Member Mediterranean Fever Commission.

(Received September 17, 1904.)

Note.—The work on the examination of urine, fæces and mosquitoes has been done in conjunction with Captain Kennedy, R.A.M.C.

1. *Examination of Urine.*

In my report on previous work performed at Gibraltar, it was pointed out that the ordinary restraining agents, such as carbolic acid, sodium taurocholate, malachite green, etc., could not be depended upon to inhibit the growth of the micro-organisms usually found associated with the *M. melitensis* in the urine of Mediterranean fever cases. Accordingly, in the earlier work at Malta, attempts were made to isolate the Micrococcus by first enriching a known bulk of urine with broth, usually in the proportions of 1—1 and 1—3, and then, after varying periods of incubation at 37° C., plating the growths, which resulted, on nutrose agar. It was hoped that, under these conditions, the specific microbe would so multiply as to enable colonies to be detected by the plate method. A very short experience showed that the enrichment method was not satisfactory; the extraneous organisms multiplied more vigorously than the *M. melitensis*, and the latter was completely crowded out. It was then decided to make use of the glucose-litmus-nutrose-agar plates, already mentioned in the Gibraltar report, and to add small quantities of urine, 0·25—0·33 c.c., to these plates, allowing the urine to flow over and form a thin layer on the surface of the solidified agar. This procedure enabled the actual number of colonies of the Micrococcus passed in the urine to be ascertained. Before collecting the urine for investigation, the genitalia were washed with carbolic acid lotion; the patient then passed urine, but the first portion, which acted as a flush to the urethra, was discarded. On the glucose-litmus-nutrose-agar plates, the colonies of the *M. melitensis* appeared as almost transparent deep blue drops; likely colonies were next fished, and made into an

emulsion with normal salt solution on a cover-glass. It may be noted that the *M. melitensis* readily emulsifies, and the culture appears to flow off the point of the needle into the surrounding fluid; this characteristic was found of great assistance in detecting the specific microbe. A streptococcus is found in urine which produces, on the special plates, colonies very closely resembling those of the *M. melitensis;* when fished, however, they do not readily emulsify, and, on examination, under one-twelfth, are found to consist of a medium-sized coccus, staining with Gram. When it was found that the colony readily emulsified, the hanging drop was carefully examined under the oil immersion, in order to ascertain the nature of the organism, and to make sure that no false clumps were present. If the microbe presented the characteristics of the *M. melitensis*, and the emulsion was satisfactory, the cover-glass was removed, and a little specific animal serum added. In the earlier work I employed a rabbit serum prepared at Gibraltar, but, in the later work, serum from Monkey 45 was used. When the microbe under examination manifested instantaneous clumping under the influence of the serum, a portion of the colony was planted out on an agar slope, and incubated at 37° C. The resulting growth was then treated as follows:—

(1) Tested with the serum of Monkey 45. This serum, when diluted 1—1000, was found to cause instantaneous clumping, visible to the naked eye, of the laboratory stock culture of *M. melitensis.*

(2) Planted in glucose-litmus-peptone, or on a glucose-litmus-agar slope, and incubated for 7 days at 37° C.

(3) Planted in litmus milk and incubated for a month at 37° C.

(4) Examined as to retention of stain by Gram's method.

A micro-organism, which agglutinates with a specific animal serum in a high dilution, does not ferment glucose, renders milk alkaline without coagulation, may justly be regarded as the *M. melitensis.*

All the strains of *M. melitensis*, which have been isolated from the urine of Mediterranean fever cases, have responded to these tests.

Employing the above technique the first successful isolation was obtained from the urine of Sergeant Pudney, 2nd Essex Regiment. A plate made with 0·33 c.c. of urine was found to contain thirty-three colonies, after 5 days' incubation at 37° C.; colonies were first observed on the 4th day, but the maximum number did not appear until the 5th day of incubation.

The *M. melitensis* has now been isolated thirty-nine times, and from the urine of thirteen different patients. Colonies were never observed before the 3rd day of incubation, and at this period they were usually very minute and easily missed; on the 4th day of incubation, however, they were readily detected on the glucose-litmus-nutrose-agar plates. The actual numbers of *M. melitensis* isolated from urine are shown in the attached table (A).

Table A.—Showing the Number of Colonies of *M. melitensis* found in each Sample of Urine.

Name.	Date.	Quantity of urine in c.c.	No. of colonies in each plate.	No. of colonies per c.c.	Average No. per c.c.
Howe	6.7.04	Isolated from broth culture made with urine obtained at the *post-mortem* examination.			
Pudney	18.7.04	0·5	1	2	
		0·33	33	99	50
"	25.7.04	0·25	3		
		0·25	3	12	26
		0·25	3		
		0·25	3		
		0·25 (mucus)	21	84	
"	27.7.04	0·33	2	6	6
Martin	2.8.04	0·33	95	285	285
Markham	6.8.04	0·25	5	20	20
Breuster	6.8.04	0·25	2	8	8
Belfield	6.8.04	0·33	1	3	3
Pudney	7.8.04	0·125	1	8	8
"	8.8.04	0·5	4	8	8
Fisher	8.8.04	0·33	3	9	15
		0·33	7	21	
Lawson	12.8.04	0·25	1	4	4
Breuster	13.8.04	0·25	2	8	8
Lawson	14.8.04	0·33	4	12	12
"	14.8.04	0·33	5	15	15
"	15.8.04	0·25	6	24	24
Lawrence	16.8.04	0·25	1	4	4
		0·25	1	4	
Lawson	17.8.04	0·25	45	180	180
Fisher	19.8.04	0·25	1	4	4
Lawson	20.8.04	0·33	12	36	36
Griffin	20.8.04	0·25	10	40	40
Lawson	21.8.04	0·33	15	45	45
Griffin	23.8.04	0·25	1	4	4
Lawson	23.8.04	0·33	105	315	315
Pudney	23.8.04	0·33	2	6	6
Breuster	24.8.04	0·25	1	4	4
Griffin	24.8.04	0·25	1	4	4
Lawson	26·8.94	0·33	1	3	3
Markham	26.8.04	0·33	1	3	3
Lawson	29.8.04	0·33	3	9	9
Barry	29.8.04	0·33	1	3	3
Christie	29.8.04	0·33	4	12	12
Lawson	31.8.04	0·33	1	3	3
Lawrence	1.9.04	0·33	3	9	9
Markham	1.9.04	0·33	1	3	3
Griffin	9.9.04	0·33	5	15	15
Lawrence	10.9.04	0·33	70	210	210
Kinsella	16.9.04	0·33	1	3	15
		0·33	9	27	
Markham	28.9.04	0·5	298	596	596

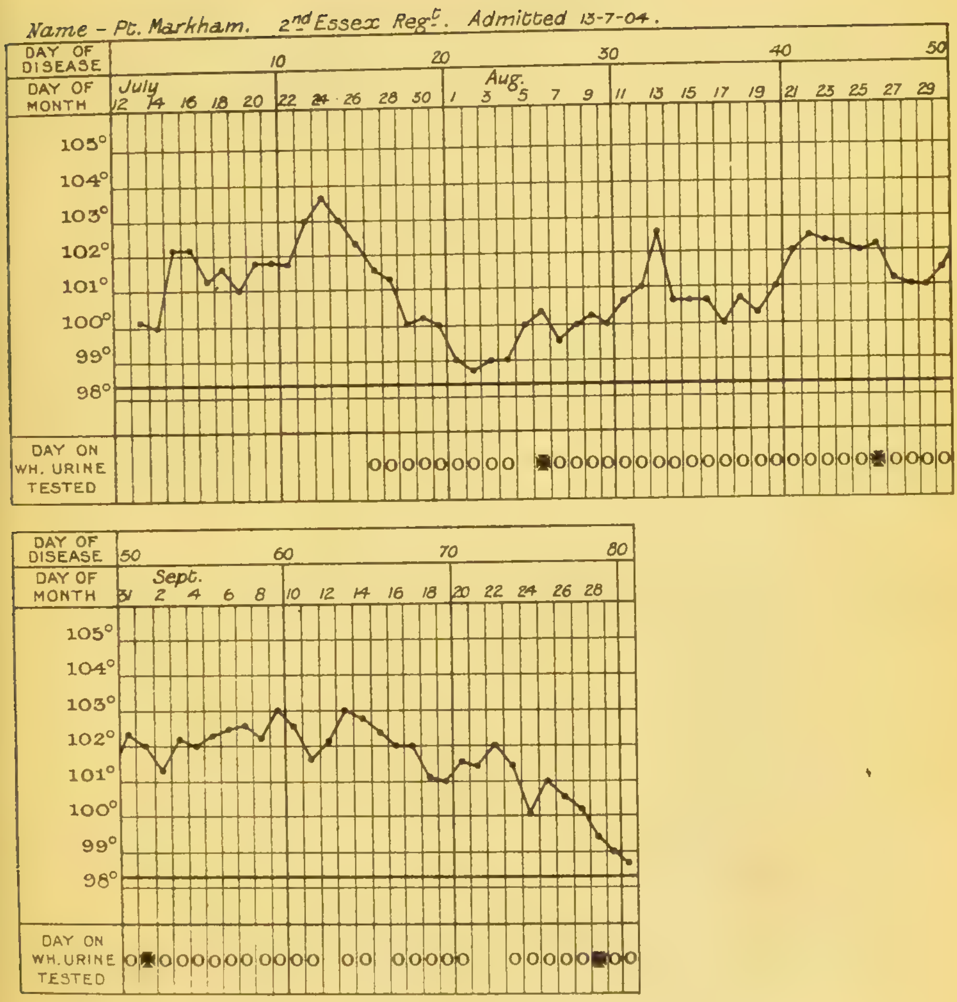
Up to the present time the Micrococcus has not been isolated from urine earlier than the 15th day or later than the 82nd day of disease.

It is present in the urine of patients who are sufficiently convalescent to be allowed up, but still have an evening rise of temperature.

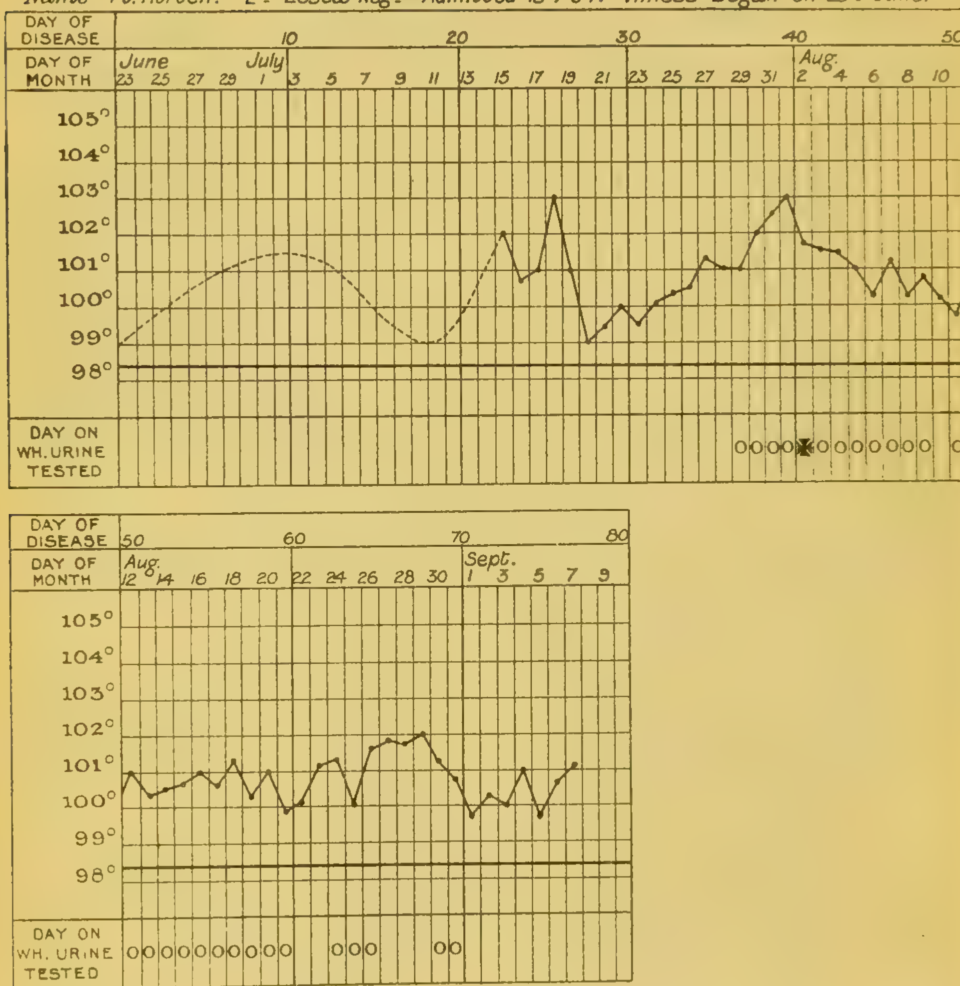
In order to save repetition and to enable the work done to be grasped at a glance, the attached charts have been prepared by Captain Kennedy, Royal Army Medical Corps, who has given me most valuable assistance throughout the work. Each square represents a day of disease, and in every case the chart commences with the day which, after careful questioning of the patient, was considered to be probably the 1st day of disease; so that on looking through the charts the different columns represent the same day of disease for each patient. The course of the fever is represented by the evening temperature, and the 0 sign indicates an examination made without any result; the Maltese cross sign represents a successful isolation of the *M. melitensis.* It will be noticed that there are many failures as compared with successes. In the earlier work the constant want of success was undoubtedly due to the faulty method of procedure; but in the later work it is to be attributed partly to the fact that the *M. melitensis* is not voided in the urine every day, but appears in gushes at uncertain periods, and partly to the presence in the urine of acid-producing organisms, which outgrow and interfere with the development of the *M. melitensis.*

Careful observation of the urines has been made in order to ascertain whether any physical or chemical change is associated with the passage of the *M. melitensis.* All the urines have been free from the general opacity or turbidity, which is associated with Typhoid Bacilluria. A little deposit of mucus has been observed, and a portion of this when plated out has always given more colonies than the clear portion of the urine treated in the same manner. On three occasions a trace of albumen was noticed, but up to the present no physical or chemical change common to all the urines and indicating the passage of the *M. melitensis* has been observed.

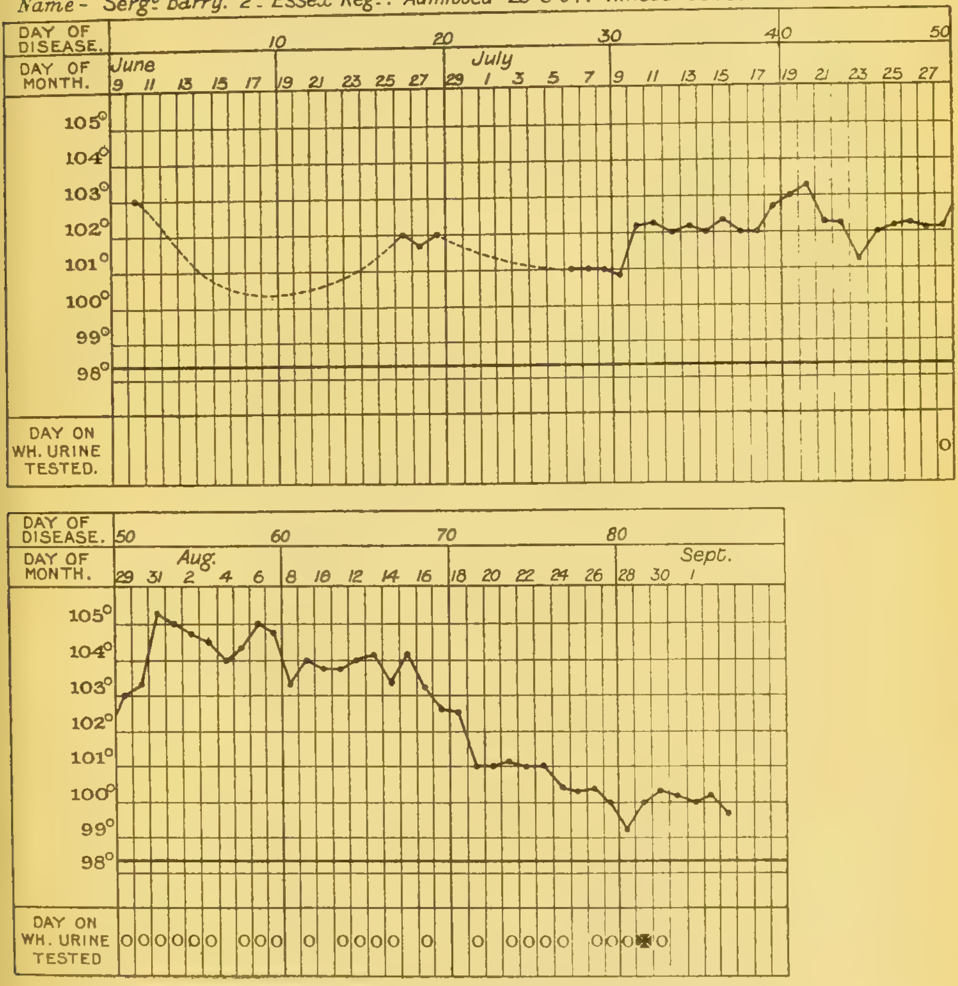
Table A shows the number of micrococci per cubic centimetre obtained from each sample of urine, and indicates the dates when the isolation was effected. It will be noticed that the numbers of micrococci excreted are small as compared with the figures recorded by several observers during the bacilluria of typhoid fever. It is possible that the figures given in the table do not represent the actual numbers passed in every case, and that many colonies escaped observation owing to their being crowded out by other microbes. At the same time many of the plates, notably those of Sergeant Pudney and Private Lawson, were nearly pure cultures of *M. melitensis*, and as all the colonies which appeared were perfectly discrete, and there was ample room in the plates for other colonies to develop had they been present, it does not seem probable that the numbers passed greatly exceeded the maximum figures recorded.

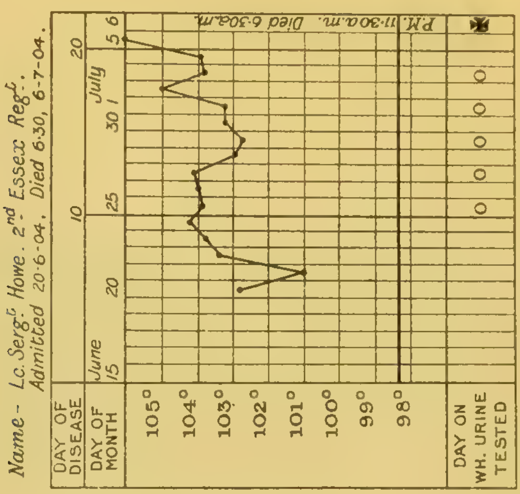

Name – Pt. Markham. 2nd Essex Regt. Admitted 13-7-04.
DAY OF DISEASE
DAY OF MONTH
July
Aug.
Sept.
105°
104°
103°
102°
101°
100°
99°
98°
DAY ON WH. URINE TESTED

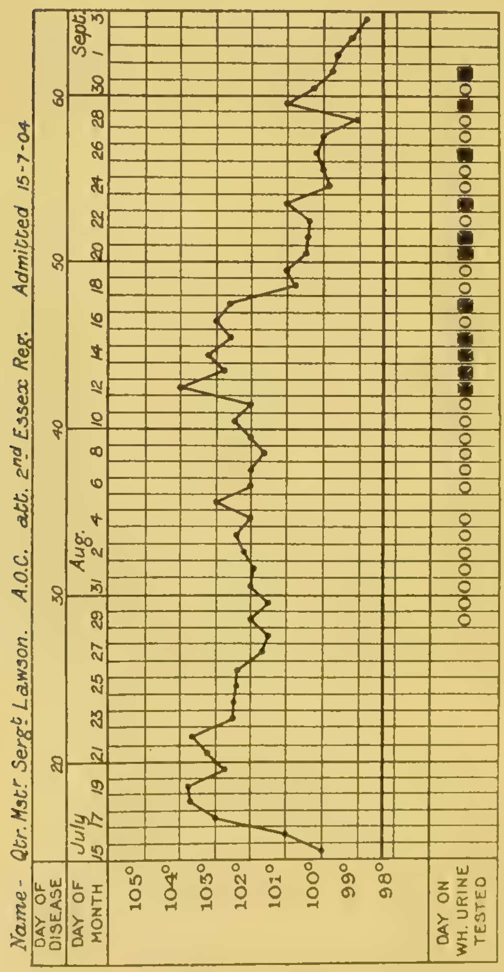
Name—Pt. Morten. 2nd Essex Regt. Admitted 15-7-04. Illness began on 23rd June.

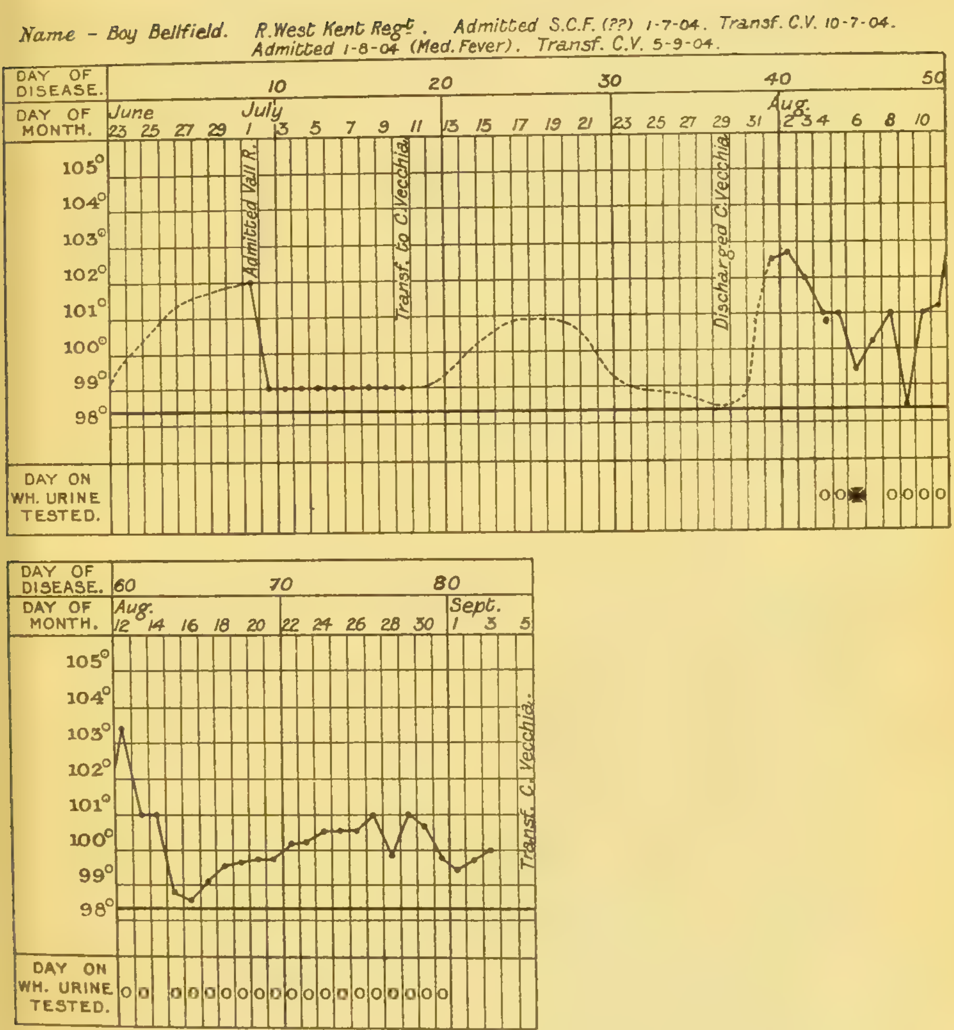


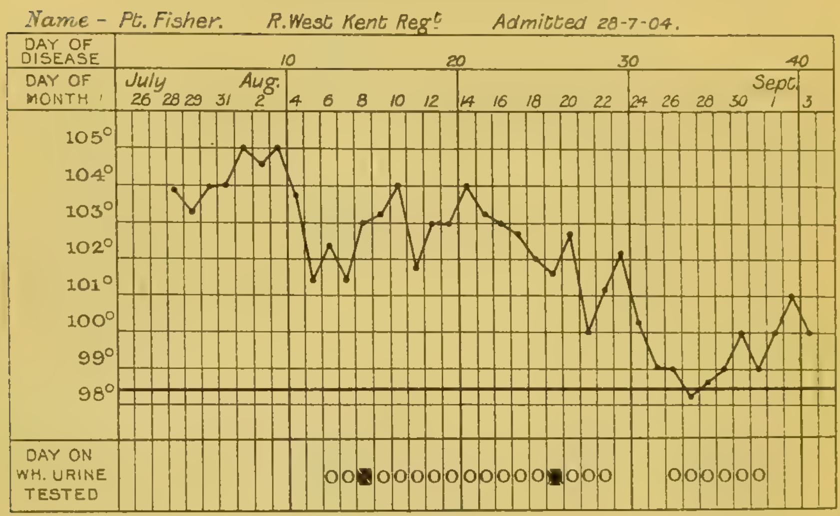
Name - Sergt. Barry. 2nd Essex Regt. Admitted 26-6-04. Illness dates from 9-6-04.

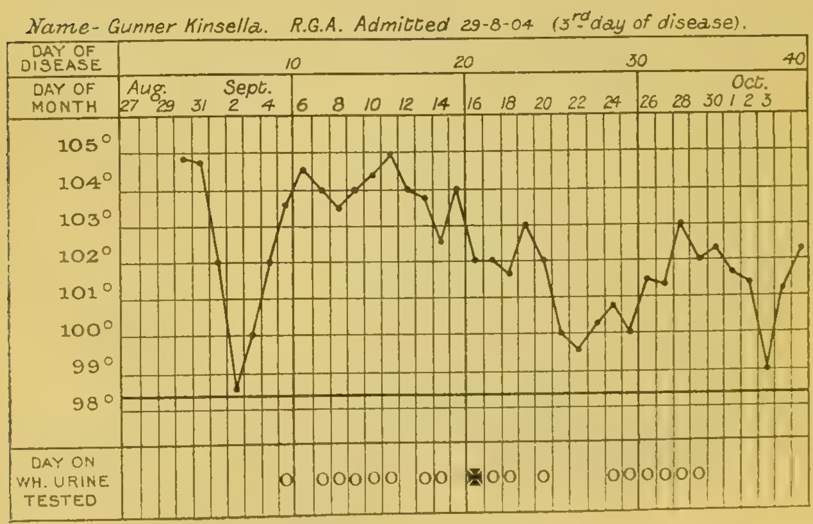



Name - Lc. Sergt. Howe. 2nd Essex Regt.
Admitted 20-6-04. Died 6.30, 6-7-04.
DAY OF DISEASE
DAY OF MONTH
DAY ON WH. URINE TESTED
105°
104°
103°
102°
101°
100°
99°
98°
June
July
P.M. 11-30 a.m. Died 6-30 a.m.

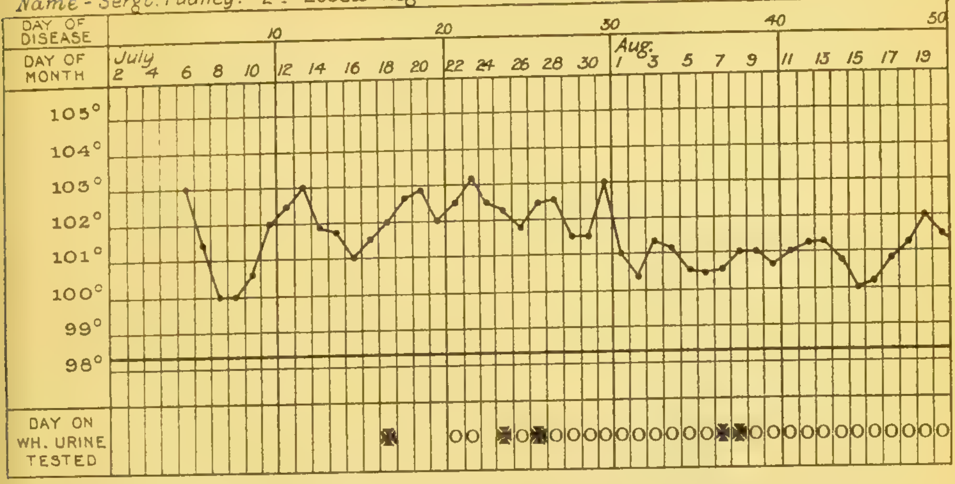

Name - Qtr. Mstr. Sergt. Lawson. A.O.C. att. 2nd Essex Reg. Admitted 15-7-04
DAY OF DISEASE
DAY OF MONTH
DAY ON WH. URINE TESTED
105°
104°
103°
102°
101°
100°
99°
98°
July
Aug.
Sept.

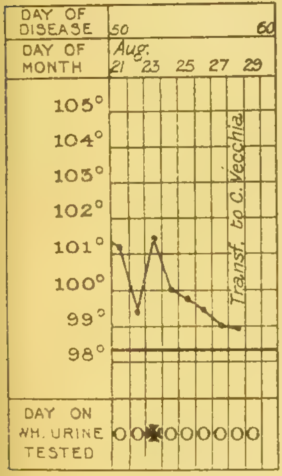

Name - Boy Bellfield. R.West Kent Regt. Admitted S.C.F. (??) 1-7-04. Transf. C.V. 10-7-04.
Admitted 1-8-04 (Med. Fever). Transf. C.V. 5-9-04.
DAY OF DISEASE.
DAY OF MONTH.
DAY ON WH. URINE TESTED.
Admitted Vall R.
Transf. to C. Vecchia.
Discharged C. Vecchia.
Transf. C. Vecchia.



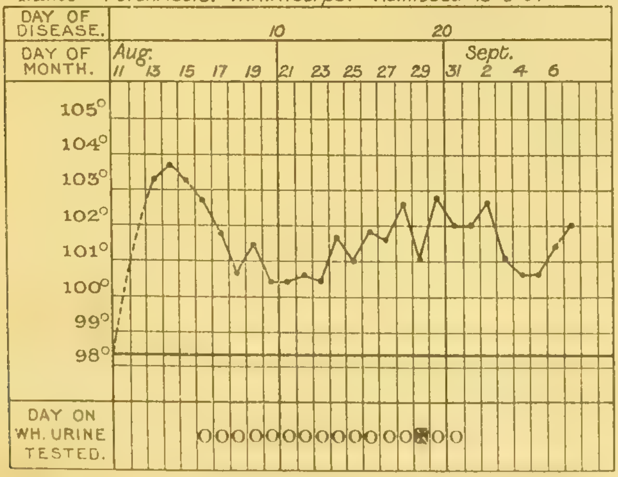


Name - Sergt. Pudney. 2nd Essex Regt.. Admitted 6-7-04. Transferred convalescent 29-8-04

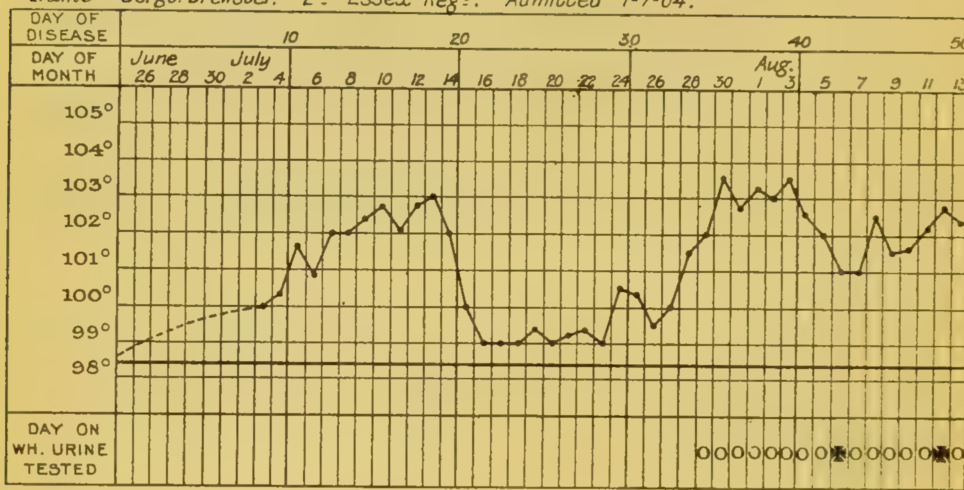


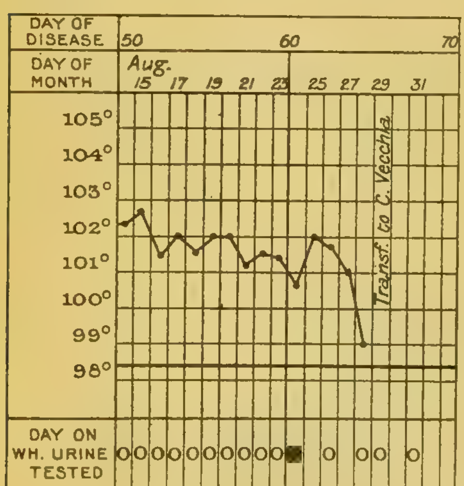


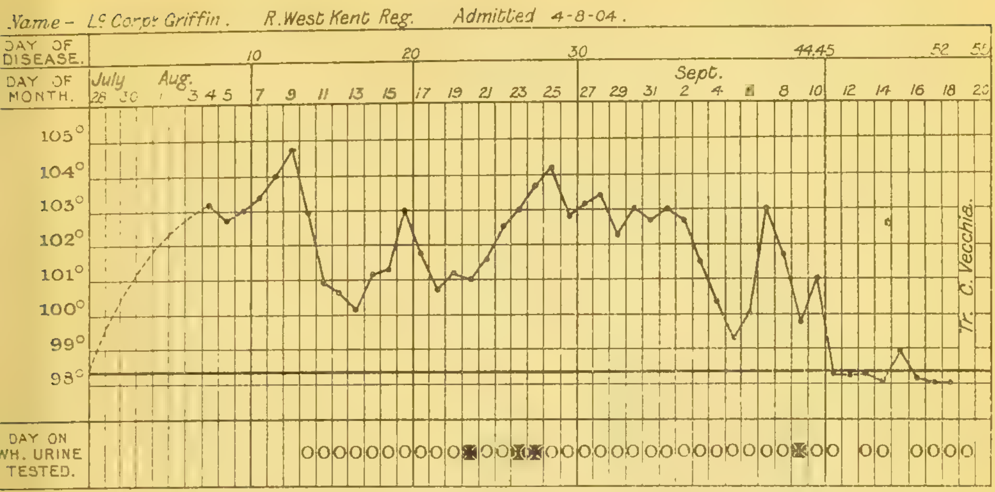
Name - Pt. Christie. R.A.M. Corps. Admitted 13-8-04

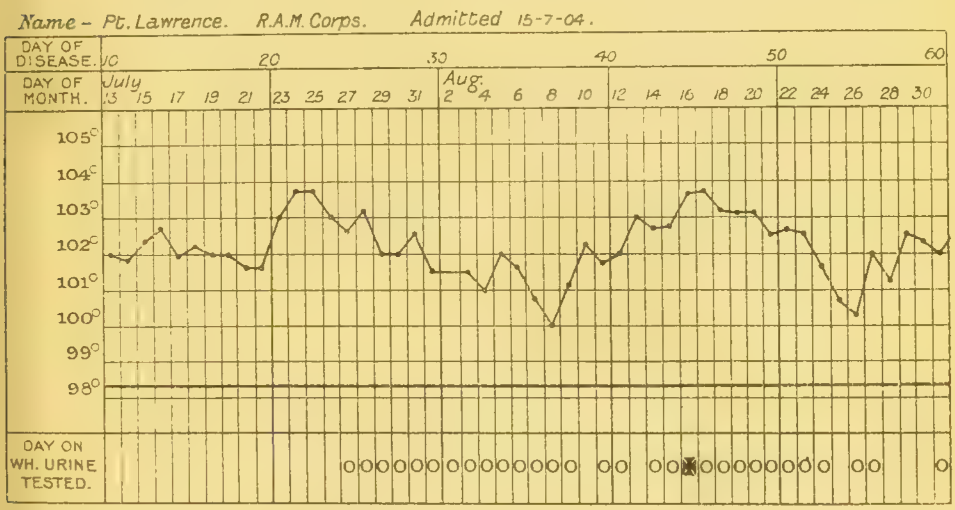


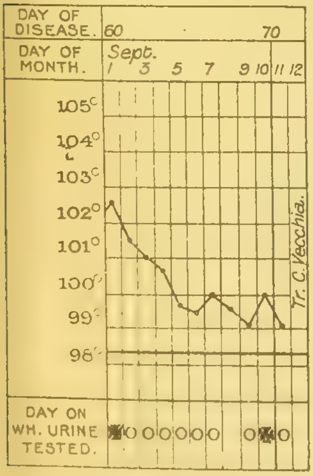
Name- Sergt. Brewster. 2nd Essex Regt. Admitted 1-7-04.






Name – Lc Corpl Griffin. R. West Kent Reg. Admitted 4-8-04.
DAY OF DISEASE.
DAY OF MONTH.
July
Aug.
Sept.
DAY ON WH. URINE TESTED.
Tr. C. Vecchia.


Name – Pt. Lawrence. R.A.M. Corps. Admitted 15-7-04.
DAY OF DISEASE.
DAY OF MONTH.
July
Aug.
DAY ON WH. URINE TESTED.


DAY OF DISEASE.
DAY OF MONTH.
Sept.
DAY ON WH. URINE TESTED.
Tr. C. Vecchia.

Up to the present 520 samples of urine have been examined, representing the study of more than 1000 plates.

2. *Examination of Fæces.*

Having succeeded in isolating the *M. melitensis* from the urine of Mediterranean fever cases, attempts were now made to detect the microbe in the fæces of these patients. Unfortunately, most of the cases suffered from constipation, and the bowels only acted after the administration of an enema. A few patients suffered from diarrhœa for a short time, and the opportunity was taken of investigating these stools.

The great difficulty to contend with in the study of fæces is caused by the presence of the rapidly growing *B. coli* in large numbers. The enrichment method, which failed with the urine, appeared to be even less likely to yield satisfactory results with fæces. A few trials were made of planting out some of the stools in broth and then, after incubating for four days at 37° C., plating out the growths on glucose-litmus-nutrose-agar plates. The results were highly unsatisfactory; the *B. coli* and its allies converted the plates into a strongly acid medium, on which the *M. melitensis* would not grow. Evidently a medium on which the *B. coli* could not develop, would prove of great assistance in isolating the *M. melitensis* from stools. E. Roth in the *Archiv f. Hygiene* of March 3, 1904, reported that the development of the *B. coli* was arrested in a medium containing 60 per cent. of a solution containing $\frac{1}{100}$th of caffeine. For greater security against the development of *B. coli* he recommended the proportion of caffeine to be increased to 115 per cent. of the $\frac{1}{100}$th solution. Ficker and Hoffmann in the same number of the *Archiv f. Hygiene* also attested the value of caffeine in arresting the development of *B. coli*; they used 5 grammes of caffeine per litre of fluid. Courmont and Lacomme also wrote on caffeine in bacteriology in the March number of the *Journal of Physiology and Pathology*, 1904. They stated that when caffeine was added to broth to the extent of 1 per cent., the development of *B. coli* was prevented. In view of these statements, experiments were made to test the viability of the *M. melitensis* in caffeinised media. Broth tubes were prepared containing 0·5 per cent., 0·75 per cent., and 1 per cent. of caffeine. Each tube was inoculated with a small loopful of an agar growth, derived from the spleen of Sergeant Howe. The results obtained were as follows :—

(1). 5.8.04, 0·5 per cent. Caffeine broth, inoculated with *M. melitensis* spleen culture of man, incubated at 37° C.

(2). 5.8.04, 0·75 per cent. Caffeine broth, inoculated with *M. melitensis* spleen culture of man, incubated at 37° C.

(3). 5.8.04, 1 per cent. Caffeine broth, inoculated with *M. melitensis* spleen culture of man, incubated at 37° C.

(1). 8.8.04, 0·5 per cent. Good growth. Planted out on agar and *M. melitensis* recovered.

(2). 8.8.04, 0·75 per cent. No growth.
(3). 8.8.04, 1 ,, ,,
(2). 9.8.04, 0·75 ,, ,,
(3). 9.8.04, 1 ,, ,,
(2). 10.8.04, 0·75 ,, ,,
(3). 10.8.04, 1 ,, ,,
(2). 11.8.04, 0·75 ,, ,,
(3). 11.8.04, 1 ,, ,,
(2). 12.8.04, 0·75 ,, ,,
(3). 12.8.04, 1 ,, ,,
(2). 15.8.04, 0·75 ,, ,,
(3). 15.8.04, 1 ,, ,,

(2). 18.8.04, 0·75 per cent. No growth. Planted out on agar slopes. No growths appeared.

(3). 18.8.04, 1 per cent. No growth. Planted out on agar slopes. No growths appeared.

Result.—*M. melitensis* derived from the spleen of man does not appear to develop in media containing more than 0·5 per cent. of caffeine.

Courmont and Lacomme having stated in their paper that cultures of *B. typhosus* from urine were more resistant to the action of caffeine than cultures derived from the blood, experiments were made to see if the same held good for cultures of *M. melitensis.* Accordingly, batches of the same broth used in the previous experiments were inoculated with an agar culture obtained from Sergeant Pudney's urine; the tubes were incubated at 37° C.

The results obtained were as follows :—

(1). 5.8.04, 0·5 per cent. Caffeine broth, inoculated with culture from urine.

(2). 5.8.04, 0·75 per cent. Caffeine broth, inoculated with culture from urine.

(3). 5.8.04, 1 per cent. Caffeine broth, inoculated with culture from urine.

(1). 8.8.04, 0·5 per cent. Good growth. Planted on agar. *M. melitensis* recovered.

(2). 8.8.04, 0·75 per cent. Very feeble growth. Planted on agar. *M. melitensis* recovered.

(3). 8.8.04, 1 per cent. Very feeble growth. Planted on agar. *M. melitensis* recovered.

Result.—The *M. melitensis* derived from urine is able to grow, but only feebly, in broth containing 0·75 and 1 per cent. of caffeine.

A culture of *B. coli* isolated from the stool of a Mediterranean fever case was next tested as to its growth in caffeinised broth. The results obtained were as follows :—

(1). 16.8.04, 0·5 per cent. Caffeine broth, inoculated with *B. coli* from stool of Mediterranean fever case.

(2). 16.8.04, 0·75 per cent. Caffeine broth inoculated with *B. coli* from stool of Mediterranean fever case.

(3). 16.8.04, 1 per cent. Caffeine broth, inoculated with *B. coli* from stool of Mediterranean fever case.

(1). 17.8.04, 0·5 per cent. Good growth. Planted on agar. *B. coli* recovered.

(2). 17.8.04, 0·75 per cent. No growth.

(3). 17.8.04, 1 ,, ,,

(2). 18.8.04, 0·75 ,, ,,

(3). 18.8.04, 1 ,, ,,

(2). 19.8.04, 0·75 per cent. Feeble growth. Planted on agar. A few colonies of *B. coli* appeared.

(3). 19.8.04, 1 per cent. Feeble growth. Planted on agar. A few colonies of *B. coli* appeared.

Result.—Caffeine in the proportion of 0·75 and 1 per cent. appeared to have a distinct restraining influence on the growth of *B. coli.*

An emulsion of one loop of *B. coli* and one loop of *M. melitensis*, from a urine culture, was now thoroughly mixed and then plated out on 0·75 per cent. caffeine-glucose-nutrose-litmus-agar. As a result a few colonies of *B. coli* appeared in 48 hours, but no signs of the *M. melitensis* were observed even after 6 days' incubation at 37° C. ; evidently the use of media containing more than 0·50 per cent. of caffeine would be attended with considerable risk of arresting the growth of the *M. melitensis.*

A batch of plates, containing 0·5 per cent. of caffeine in addition to the usual glucose-nutrose-litmus-agar, was now prepared. An emulsion of a stool from a Mediterranean fever case was plated out, and as a control the same emulsion in the same quantities was plated on the ordinary glucose-nutrose-litmus-agar. After 48 hours' incubation at 37° C., there was no appreciable difference between the plates, so the use of caffeine was abandoned in this investigation. The technique has consisted in adding loopfuls of the fluid stools, the number of loops depending on the fluidity of each stool, to either sterile salt solution or broth until a slightly opalescent mixture was produced. Loopfuls of the mixture were then stroked concentrically or diffused by means of a " platinum spreader " over the surface of glucose-litmus-nutrose-agar, solidified in Petri dishes. The plates were then placed with the covers downwards in the 37° C. incubator. After 4 and 5 days' incubation the resulting colonies were examined in a hanging drop; if anything like the morphology of *M. melitensis* appeared, the cover-glass was removed, and a loopful of the specific serum, diluted 1—10, added. Many of the streptococci occurring in stools bear a superficial resemblance to the *M. melitensis* : still, as a rule,

Table showing the Days of Disease on which the Stools were Examined, and the Number of Plates made.

No. of case.	Name.	Days of Disease.																																														Total.
		11	12	13	15	16	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	42	43	46	48	49	50	51	52	53	55	56	57	59	60	62	76	77	101	
1	Barry																																					6							12	4	14	36
2	Eldred														4	10																																14
3	Francis							3	3																																							6
4	Vince						5																								9				4													18
5	Moore													5																																		5
6	Brewster																													5																		5
7	Corporal Jones																																						4	3	4							11
8	Griffin				4			8	9	4		4		21		4						16																										70
9	Mays																												4																			4
10	Fisher									8	19	3	6	16	8				16													15	20	15			10				20			12				168
11	Christie							14				21						15	14	18	11		10	10																								113
12	Lawrence																																											8				8
13	Hurrell											24		21	30		15																		14													104
14	Vince																																			14												14
15	Curry									11																																						11
16	Campbell															22																																22
17	Ingram																																															15
18	Groom													20	12	12																																44
19	Gane											12																																				12
20	Silcox																								10	12	10	10	20	14		12																88
21	Private Jones			11						14																																						25
22	Silburn		10			14																																										24
23	Smith													14		12	12	22	12	16																												88
24	Martin								13													12																										25
25	Iggo	12																																														12
26	Rowlands																																									12	12					24
27	Rantoime												14																																			14
28	Kinsella																		16																													16
29	Anthony						14	16																																								30
	No. of plates	12	10	11	4	14	19	41	25	37	19	64	20	97	54	60	27	37	58	34	11	28	10	10	10	12	10	10	24	19	9	27	20	15	18	14	10	6	4	3	24	12	12	20	12	4	14	1026

the colonies have a faint opacity and sometimes a reddish tinge which enables them to be at once distinguished from the *M. melitensis*. In any case of doubt the addition of the specific serum enabled a diagnosis to be made. The attached table shows the number of stools examined and the results up to the present time. It will be seen that 1026 plates made from eighty-six stools have been studies, but with a negative result.

Examination of Stools of Mediterranean Fever Cases.

Name.	Dates.	Number of plates.	Day of disease.	Result.
1. Barry	31.7.04	6	53	*M. melitensis* not isolated.
2. ,, ...	23.8.04	12	76	,, ,,
3. ,, ...	24.8.04	4	77	,, ,,
4. Eldred	27.7.04	10	27	,, ,,
5. ,, ...	26.7.04	4	26	,, ,,
6. Francis	17.7.04	3	19	,, ,,
7. ,, ...	18.7.04	3	20	,, ,,
8. Vince	23.7 04	5	18	,, ,,
9. ,, ...	17.8.04	9	43	,, ,,
10. ,, ...	24.8.04	4	50	,, ,,
11. Moore	25.7.04	5.	25	,, ,,
12. Brewster	5.8.04	5	42	,, ,,
13. Jones	7.8.04	4	55	,, ,,
14. ,, ...	8.8.04	3	56	,, ,,
15. ,, ...	9.8.04	4	57	,, ,,
16. Griffin	11.8.04	4	15	,, ,,
17. ,, ...	15.8.04	8	19	,, ,,
18. ,, ...	16.8.04	9	20	,, ,,
19. ,, ...	17.8.04	4	21	,, ,,
20. ,, ...	19.8.04	4	23	,, ,,
21. ,, ...	21.8.04	21	25	,, ,,
22. ,, ...	23.8.04	4	27	,, ,,
23. Mays.........	12.8.04	4	40	,, ,,
24. Fisher........	14.8.04	8	21	,, ,,
25. ,, ...	15.8.04	19	22	,, ,,
26. ,, ...	16.8.04	3	23	,, ,,
27. ,, ...	17.8.04	6	24	,, ,,
28. ,, ...	18.8.04	16	25	,, ,,
29. ,, ...	19.8.04	8	26	,, ,,
30. Christie	2.9.04	21	23	,, ,,
31. Lawrence	2.9.04	8	62	,, ,,
32. Hurrell.......	23.8.04	24	23	,, ,,
33. Fisher........	23.8.04	16	30	,, ,,
34. Hurrell.......	25.8.04	21	25	,, ,,
35. Vince	25.8.04	14	51	,, ,,
36. Hurrell.......	26.8.04	30	26	,, ,,
37. Curry	27.8.04	11	21	,, ,,
38. Hurrell	28.8.04	15	28	,, ,,
39. Griffin	28.8.04	16	33	,, ,,
40. Christie	29 8.04	14	19	,, ,,
41. Martin	8.9.04	13	20	,, ,,
42. Christie	8.9.04	15	29	,, ,,
43. Fisher........	8.9.04	15	46	,, ,,
44. Campbell	9.9.04	22	27	,, ,,
45. Christie	9.9.04	14	30	,, ,,

Examination of Stools of Mediterranean Fever Cases—*contd.*

Name.	Dates.	Number of plates.	Day of disease.	Result.
46. Ingram.......	9.9 04	15	—	*M. melitensis* not isolated.
47. Groom	10.9.04	20	25	,, ,,
48. Fisher	10.9.04	20	48	,, ,,
49. Christie	10.9.04	18	31	,, ,,
50. Groom	11.9.04	12	26	,, ,,
51. Christie	11.9.04	11	32	,, ,,
52. Fisher	11.9.04	15	49	,, ,,
53. Groom	12.9.04	12	27	,, ,,
54. Gane	12.9.04	12	23	,, ,,
55. Christie	13.9.04	10	34	,, ,,
56. Silcocks	13.9.04	10	36	,, ,,
57. Jones	13.9.04	11	13	,, ,,
58. Fisher	14.9.04	10	52	,, ,,
59. Christie	14.9.04	10	35	,, ,,
60. Silcocks	14.9.04	12	37	,, ,,
61. ,, ...	15.9.04	10	38	,, ,,
62. ,, ...	16.9.04	10	39	,, ,,
63. Silburn	16.9.04	10	12	,, ,,
64. Silcocks	17.9.04	20	40	,, ,,
65. Hurrell	19.9.04	14	50	,, ,,
66. Silcocks	19.9.04	14	42	,, ,,
67. Fisher	19.9.04	20	57	,, ,,
68. Barry	20.9.04	14	104	,, ,,
69. Smith........	20.9.04	14	25	,, ,,
70. Silburn.......	20.9.04	14	16	,, ,,
71. Jones	21.9.04	14	21	,, ,,
72. Martin	21.9.04	12	33	,, ,,
73. Iggo	21.9.04	12	11	,, ,,
74. Rowlands.....	22.9.04	12	59	,, ,,
75. Smith	22.9.04	12	27	,, ,,
76. Rowlands.....	23.9.04	12	60	,, ,,
77. Smith........	23.9.04	12	28	,, ,,
78. Silcocks	23.9.04	12	46	,, ,,
79. Fisher	24.9.04	12	62	,, ,,
80. Smith........	24.9.04	22	29	,, ,,
81. Rantiome.....	24.9.04	14	24	,, ,,
82. Kinsella......	25.9.04	16	30	,, ,,
83. Anthony	25.9.04	14	18	,, ,,
84. Smith.... ...	25.9.04	12	30	,, ,,
85. Anthony	26.9.04	16	19	,, ,,
86. Smith........	26.9.04	16	31	,, ,,

3. *Examination of Sweat.*

Critical perspirations, which are very characteristic of Mediterranean fever, have been examined at various periods of the disease, but the *M. melitensis* has not yet been isolated. The following examinations have been made:—

Experiment I.—On June 22, 1904, P . . . was noticed to be sweating profusely. The sweat was soaked up by means of sterile swabs which were then planted out in broth and rubbed over nutrose-agar plates

The tubes and plates were incubated at 37° C. On June 25, 1904, all the broth tubes showed a growth which was plated on nutrose-agar. The primary and secondary agar plates were carefully examined from time to time, but no signs of the *M. melitensis* could be discovered.

Experiment II.—At 8.30 P.M. on June 22, 1904, P . . . was again sweating profusely; swabs were treated as above, but the *M. melitensis* did not appear in the plates.

Experiment III.—At midnight on June 22, 1904, profuse sweats occurred in the same case, and the procedure detailed under Experiment I was followed. The *M. melitensis* was not isolated.

Experiment IV.—In the broth tubes, prepared as above, many contaminations were observed, which often rapidly overgrew the plates and so possibly prevented the *M. melitensis* from developing. In order to get rid of these extraneous organisms as far as possible the skin of P . . . was carefully washed with carbolic acid and ether, and a sterile pad covered by a sterile watch glass was bandaged on the right arm. On June 27, 1904, a critical sweat occurred, the pad was removed and planted out in broth; a growth occurred on June 29, 1904, which was found to consist of large Gram-staining cocci; no signs of the *M. melitensis* were discovered.

Experiment V.—On June 28, 1904, the procedure detailed under Experiment IV was followed in the case of H . . . large Gram-staining cocci again appeared.

Experiment VI.—On June 27, 1904, the same procedure was followed in the case of K . . . large and small Gram-staining cocci were isolated, but the *M. melitensis* did not appear.

Experiment VII.—On June 29, 1904, saturated pads obtained from P . . . were examined; the broth tubes remained absolutely sterile, although the incubation was continued for 10 days.

Experiment VIII.—On June 29, 1904, pads from Wildbore were planted out in broth. No growth resulted.

Experiment IX.—On June 29, 1904, pads from Wilson were planted out in broth. A growth occurred which, when plated, was found to give rise to large colonies, consisting of large cocci staining with Gram.

Experiment X.—On June 30, 1904, pads from Kelly were planted out in broth. No growth resulted.

It might be thought that the failure to obtain a growth recorded under Experiments VII, VIII, and X was possibly due to the presence in the swabs of carbolic acid, which, when transferred to the broth tubes, might inhibit the growth of the *M. melitensis*. In order to ascertain whether this was the case, sterile broth tubes, obtained in the manner detailed, were inoculated with *M. melitensis*. A typical growth resulted, showing that the failure to obtain a growth was not due to the presence of the disinfectant.

Experiment XI. Monkey No. 74.

To determine if the Injection of Sweat, from Malta Fever Patients, into a Monkey will give rise to the specific Fever.

The monkey arrived on August 29, 1904, and was taken at once to the roof of the Station Hospital, Valletta.

September 12, 1904. Skin scrapings were taken from the arms and axillæ of Private Lawrence, and ground up with normal salt solution. The resulting emulsion was injected subcutaneously into Monkey No. 74.

September 17, 1904. The blood was examined; the serum in a low dilution appeared to have a tendency to agglutinate the *M. melitensis.*

September 23, 1904. The blood was again examined, but the serum, diluted 1—10, did not show any signs of agglutinating the *M. melitensis*, even after waiting 1 hour.

September 25, 1904. Skin scrapings made into an emulsion with salt solution, were again injected.

September 27, 1904. Skin scrapings, treated as before, were injected.

September 28, 1904. The blood was examined, but the serum gave no reaction with the *M. melitensis.*

October 24, 1904. Staff-Surgeon Shaw continued the experiment up to this date. An agglutinative reaction was obtained with the serum, diluted 1—40, twenty-two days after the first injection.

The final result will be found in Dr. Shaw's experiments.

Experiment XII.

To determine if the Injection of Bacteria Free Sweat, derived from Malta Fever Patients, causes the Development of Agglutinins in the Blood of a Monkey.

Monkey No. 61A arrived in the laboratory on September 9, 1904. On September 15, 1904, and September 21, 1904, the serum was added in a low dilution to an emulsion of the *M. melitensis*; no trace of agglutination was observed.

September 22, 1904. Skin scrapings were taken from the arms and axillæ of Privates Kinsella and Silburn, who were suffering from Mediterranean Fever, and ground up with normal salt solution so as to form a fine emulsion. A sterile Berkefeld candle having been inserted into a sterile test-tube, the emulsion was filtered so as to remove all bacteria. The filtrate was then injected subcutaneously into Monkey No. 61A.

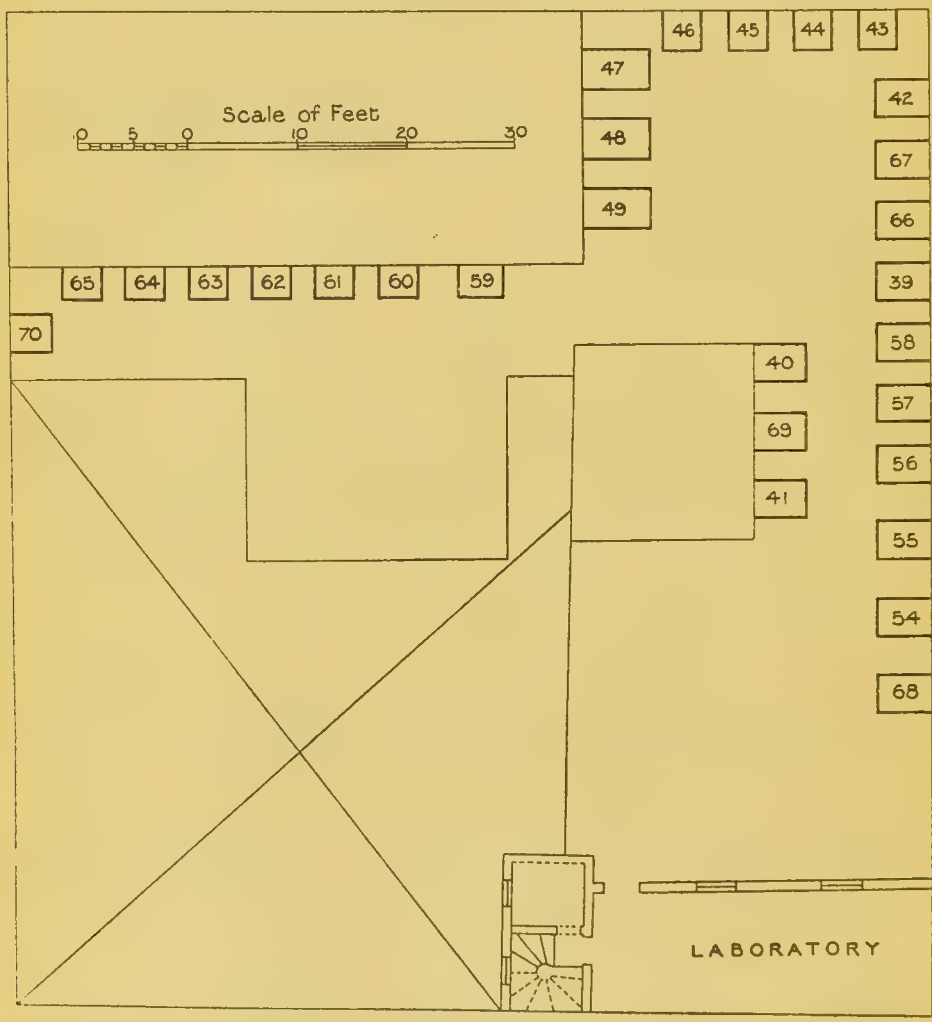
September 24, 1904. Sweat obtained from Privates Smith,

Silcocks, and Kinsella was similarly filtered, and the filtrate injected subcutaneously.

September 26, 1904. The blood was examined, and the serum found to have no action on the *M. melitensis.*

October 24, 1904. Dr. Shaw continued the experiment up to this date. The blood serum never caused the slightest agglutination of the *M. melitensis.*

Result.—The bacteria free filtrate obtained from the sweat of Malta fever patients does not appear to give rise to agglutinins in the blood of a monkey.



Plan of the Roof where Monkeys were kept, showing Position of the Animals which became naturally infected.

4. *Examination of Expired Air of Malta Fever Patients.*

In order to ascertain the presence of the *M. melitensis* in the expired air of Malta fever patients, a test-tube was fitted with an indiarubber

bung through which passed two glass tubes : one, attached to a mouthpiece, reached to the bottom of the test-tube and the other the exit tube, just passed through the bung. The test-tube was half-filled with nutrient broth and the whole apparatus then sterilised in the autoclave.

The patient under examination was directed to force expired air through the broth at frequent intervals throughout the day. The indiarubber bung, with glass tubes, was then removed, and the test-tube, being plugged with sterile cotton wool, was incubated at 37° C. After four days' incubation the broth was plated on nutrose-glucose-litmus-agar plates, and likely colonies fished and tested in the usual manner.

Case 1.—Private Markham breathed through one of these tubes on the 12.9.04; the tube was then incubated at 37° C. Four days later there was no sign of growth, but on the 19.9.04 a slight opalescence was noted. The broth was then plated on nutrose-glucose-litmus-agar. The plates were incubated for seven days, but no colonies of the *M. melitensis* appeared.

Case 2.—Private Lawrence breathed through a tube on the 12.9.04. On the 16.9.04 a marked growth appeared. A portion of the broth was plated as above, and the remainder of the growth injected into Monkey No. 73. After seven days' incubation no signs of *M. melitensis* could be discovered in the plates.

Case 3.—Private Markham again breathed through a tube on the 14.9.04. The tube was treated as before, and a slight growth was noticed on the 21.9.04. The growth was then plated, but no colonies of the *M. melitensis* appeared.

Case 4.—Private Lawrence breathed through a tube on the 14.9.04. On the 21.9.04 a slight growth appeared, which was then plated as before. No colonies of the *M. melitensis* were seen in the plates.

Case 5.—Private Kinsella breathed through a tube on the 17.9.04. On the 26.9.04 a slight growth appeared, but no colonies of *M. melitensis* were discovered in the plates made with the opalescent broth.

Case 6.—Private Silburn breathed through a tube on the 17.9.04. After twenty-four hours' incubation, the broth, being distinctly turbid, was plated in the usual manner, and incubation of the tube continued. Four days later a portion of the growth in the test-tube was plated out and the remainder of the growth injected into Monkey No. 73. No signs of the *M. melitensis* were discovered in the plates after prolonged incubation at 37° C.

Case 7.—Private Kinsella again breathed through a tube on the 20.9.04. No growth appeared in the broth, though incubation was continued for fourteen days.

Case 8.—Private Silburn breathed through a tube on the 20.9.04. A marked growth, having a putrefactive odour, appeared on the 24.9.04. This was then plated out as usual, but no colonies of the *M. melitensis* were discovered.

Case 9.—Private Silburn again breathed through a tube on the 23.9.04. The growth which appeared after incubation was treated in the usual manner, but no colonies of *M. melitensis* were isolated.

Case 10.—Private Tripp breathed through a tube on the 23.9.04. The tube was plated as before, but the *M. melitensis* was not isolated.

Case 11.—Private Anthony breathed through a tube on the 23.9.04. After the usual incubation the resulting growth was plated out, but with a negative result.

Case 12.—Private Rivers breathed through a tube on the 23.9.04. After the usual treatment, the *M. melitensis* was not isolated.

Monkey No. 73.

This monkey was reserved for the injection of broth infected by the expired air of Malta fever patients.

The monkey arrived at the laboratory on the 8.9.04. On the 15.9.04 a portion of its blood was removed and the serum, in a low dilution, added to an emulsion of the *M. melitensis*. No traces of agglutination were observed. On the 16.9.04 10 c.c. of broth infected by the breath of Private Lawrence were injected subcutaneously. On the 21.9.04 10 c.c. of broth infected by the breath of Private Silburn were injected. The action of the blood serum on the *M. melitensis* was also tested on this day, but no signs of agglutination were observed. On the 28.9.04 the blood serum was again examined, but no reaction with the *M. melitensis* was observed, though the dilution of the serum was only 1—10.

5. *Examination of Sea-water in the Grand Harbour, Malta.*

Having in view the result obtained when studying the viability of the *M. melitensis* in sea-water, and the fact that sea-water is extensively used for washing the decks of the battleships stationed in the Grand Harbour, it appeared desirable to ascertain whether the *M. melitensis* could be discovered in sea-water taken from this locality.

Studies of sea-water, when unsterilised and grossly infected with the *M. melitensis*, soon showed that the specific microbe could not be isolated, by ordinary bacteriological methods, a few days after the infection, owing to the saprophytic organisms overgrowing the colonies of the *M. melitensis*. Accordingly, it was decided to filter the sea-water through a sterile Berkefeld candle, and after washing the deposit with tap-water, to suspend it in 10 c.c. of tap-water, and inject the whole subcutaneously into a monkey.

On the 9.9.04 600 c.c. of sea-water, taken from the Grand Harbour opposite Fort St. Angelo, were pumped through a Berkefeld candle, and the deposit, having been well washed, was diffused in 10 c.c. of tap-water and injected subcutaneously into Monkey No. 71.

On the 10.9.04, the deposit from 600 c.c. of sea-water, taken from the same place, was injected.

On the 13.9.04, the deposit from 600 c.c. of sea-water, taken as before, was injected.

On the 15.9.04 the same procedure was followed.

On the 17.9.04 the same procedure was followed.

On the 18.9.04 the serum of Monkey No. 71 was added to an emulsion of the *M. melitensis.* No traces of agglutination were observed.

On the 19.9.04 600 c.c. of sea-water, taken off Fort St. Angelo, were again filtered, washed, and injected.

On the 21.9.04 the same procedure was followed.

On the 23.9.04 the same procedure was followed.

On the 25.9.04 1800 c.c. of sea-water were treated as before and the deposit injected. The serum of the monkey was added to an emulsion of *M. melitensis,* but no reaction was obtained.

On the 27.9.04 1800 c.c. of sea-water were filtered, and the washed deposit injected.

On the 29.9.04 600 c.c. of sea-water were treated as before. There is a small abscess at the site of the inoculation of the 27th.

Dr. Shaw continued this experiment up to October 22; the monkey received the bacteria contained in 30 litres of sea-water, but the blood serum never caused the slightest agglutination of the *M. melitensis.*

Result.—The *M. melitensis* could not be detected in the sea-water of the Grand Harbour.

4.

EXPERIMENTS ON THE MODE OF CONVEYANCE OF THE *MICROCOCCUS MELITENSIS* TO HEALTHY ANIMALS.

By Major W. H. HORROCKS, R.A.M.C., Member Mediterranean Fever Commission.

(Received September 17, 1904.)

Experiment I.—Monkey No. 41.

To Determine if the Inhalation of Dust, Infected with M. melitensis, *will give Rise to Mediterranean Fever in Healthy Monkeys.*

July 10, 1904. Monkey placed in cage and infected dust blown round him. Dust in bottle A used for this experiment, infected July 2, 1904.

July 11, 1904. Monkey kept in the cage and dust again blown round him. It was noticed, however, that owing to the moisture condensed on the walls, the dust soon settled, and it was impossible to keep it passing backwards and forwards through the cage. After an hour's interval, the cage was opened and the monkey allowed to come out into the room. Cage was then disinfected and dried.

July 12, 1904.	Same procedure as July 10, 1904.	
,, 13, ,,	,,	,,
,, 14, ,,	,,	,,
,, 15, ,,	,,	,,
,, 16, ,,	,,	,,
,, 18, ,,	,,	,,
,, 19, ,,	,,	,,
,, 20, ,,	,,	,,
,, 21, ,,	,,	,,
,, 22, ,,	Tested blood. No reaction.	
,, 23, ,,	Placed in cage; dust blown as before.	
,, 25, ,,	Placed in cage. The dust (bottle A) all expended.	

Planted out one loop in broth to try and determine presence of *M. melitensis.* July 26, 1904, growth planted on agar; no signs of *M. melitensis.*

July 25, 1904. Prepared more dust to-day; dust (Petri dish half full) sterilised, and then inoculated with four agar slopes, third generation from spleen of man, dried over sulphuric acid *in vacuo.*

July 29, 1904. Monkey placed in cage and dust blown as before; dust dried over sulphuric acid employed.

July 31, 1904. Monkey placed in cage and dust blown as before; dust dried over sulphuric acid employed.

Note.—The dust appears to fall very rapidly; only seen on the nostrils. Mouth, as a rule, kept tight shut.

August 1, 1904. The same procedure as on July 29, 1904.

" 2, " " "

August 3, 1904. The same procedure as on July 29, 1904. Planted out soil in broth to see if *M. melitensis* still present; growth August 6, 1904, planted on agar. *M. melitensis* recovered.

August 4, 1904. The same procedure as on July 29, 1904; dust all expended.

August 5, 1904. Fresh dust prepared. Four tubes, second generation, spleen of Howe, incubated 3 days at 37° C., dried 24 hours over sulphuric acid and $CaCl_2$ *in vacuo.* Dust blown in cage. Dust planted out in broth on August 4, 1904, to ascertain presence of *M. melitensis.* August 8, 1904, planted on glucose agar; no *M. melitensis,* isolated; broth probably contaminated. This batch of broth found to be contaminated with *B. mesentericus.*

August 6, 1904. Dust blown in cage as on August 5, 1904. Dust planted out in broth August 9, 1904. Growth planted on agar August 10, 1904; broth contaminated, cause probably as on August 4, 1904.

August 8, 1904. Dust blown as before.

August 9, 1904. Planted out dust in broth (proved by incubation). On August 13, 1904, growth planted on glucose-litmus-agar, *M. melitensis* present.

August 10, 1904. Dust blown as before.

August 16, 1904. Examined blood; serum gave no reaction with *M. melitensis* in a dilution of 1 in 10.

August 26, 1904. Examined blood; serum reacted at once with *M. melitensis* in a dilution of 1 in 20; no reaction 1 in 50.

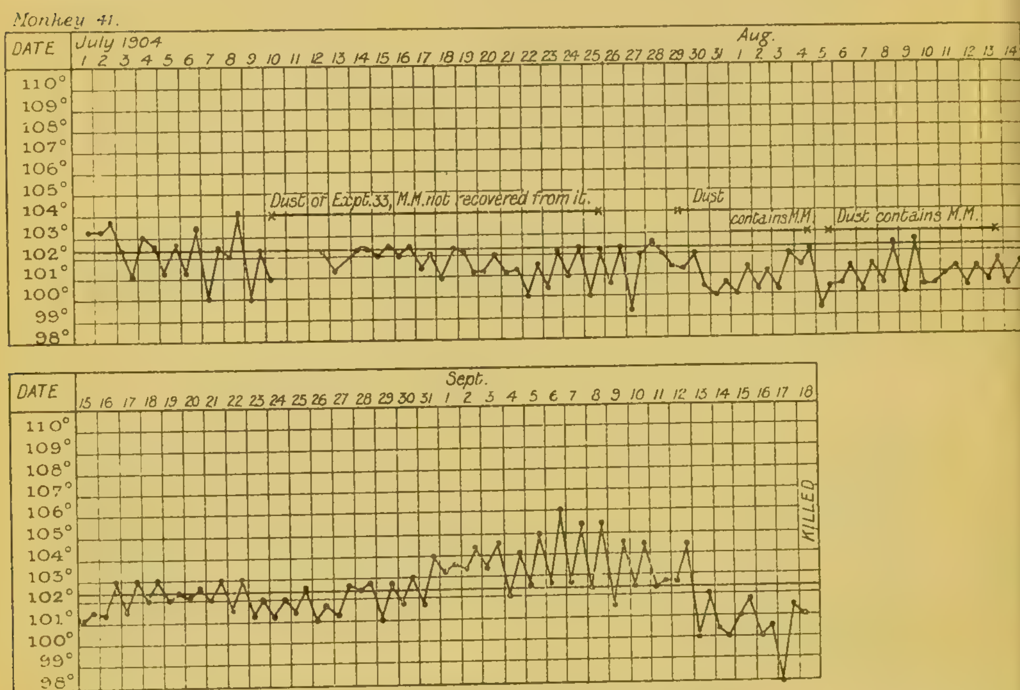
September 6, 1904. Examined blood; serum reacted at once, visible to naked eye, dilution 1—100; no reaction 1—500.

September 15, 1904. Examined blood; serum reacted at once, visible to naked eye, dilution 1—50; reaction incomplete in a dilution of 1—100.

September 19, 1904. Killed the monkey with chloroform. *Post-mortem* examination: Spleen enlarged, soft, and friable. Liver and kidneys congested. Made cultures from spleen, liver, and kidneys, urine, and heart's blood.

September 23, 1904. *M. melitensis* isolated from spleen of this monkey. Cultures made from liver, kidneys, and heart's blood are sterile.

The following chart represents the course of the *rectal* temperature :



Monkey No. 41.

Note.—The wave of fever did not commence until August 31, though a slight serum reaction was obtained on August 26. The first date on which the dust was known to contain the *M. melitensis* was July 29, consequently the incubation period might have varied from 17 to about 30 days.

Result.—This experiment seems to show that the inhalation or ingestion of infected dust will give rise to the disease.

Experiment II.—Monkey No. 47.

To determine if the Injection of Dust, infected with M. melitensis, *into the Nostrils and Throat will give rise to Mediterranean Fever in Healthy Monkeys.*

July 9, 1904. Injected dry dust containing *Micrococcus melitensis*, 7 days old, into both nostrils of above monkey. (Bottle A of July 2, 1904, used—Experiment 33.)

July 10, 1904. Injection repeated.

„ 11, „ „

„ 12, „ „

July 13, 1904. Injection repeated.
,, 14, ,, ,,
,, 21, ,, Examined blood; no reaction with *M. melitensis.*
,, 28, ,, ,, ,, ,,
,, 29, ,, Injected infected dust, dried 2 days over sulphuric acid *in vacuo*, into back of throat; lips covered with a cloth, and tube passed through a wooden gag.

July 30, 1904. Injection repeated as on July 29, 1904.
August 1, ,, ,, ,,
,, 2, ,, ,, ,,
,, 3, ,, ,, ,,
,, 4, ,, ,, ,,
,, 5, ,, Injection repeated, fresh dust prepared from four agar slopes, spleen Howe, second generation, incubated 3 days at 37° C., then dried for 24 hours over sulphuric acid and calcium chloride *in vacuo.*

August 6, 1904. Injection repeated as on August 5, 1904.
,, 8, ,, Injection repeated. The greatest care is being taken to prevent abrasions of the mucous membrane; a wooden gag is inserted between the teeth as before.

August 9, 1904. Examined blood; serum reacts completely to naked eye, dilution 1—40; slight reaction 1—80. No abrasions to be seen in the mouth; on the skin of the lower lip there is a very small abrasion, caused by the gag, but it is unlikely that this was the source of infection, as the lips have been covered as much as possible when the dust was blown.

August 16, 1904. Complete reaction at once 1—100, naked eye; slight reaction 1—300.

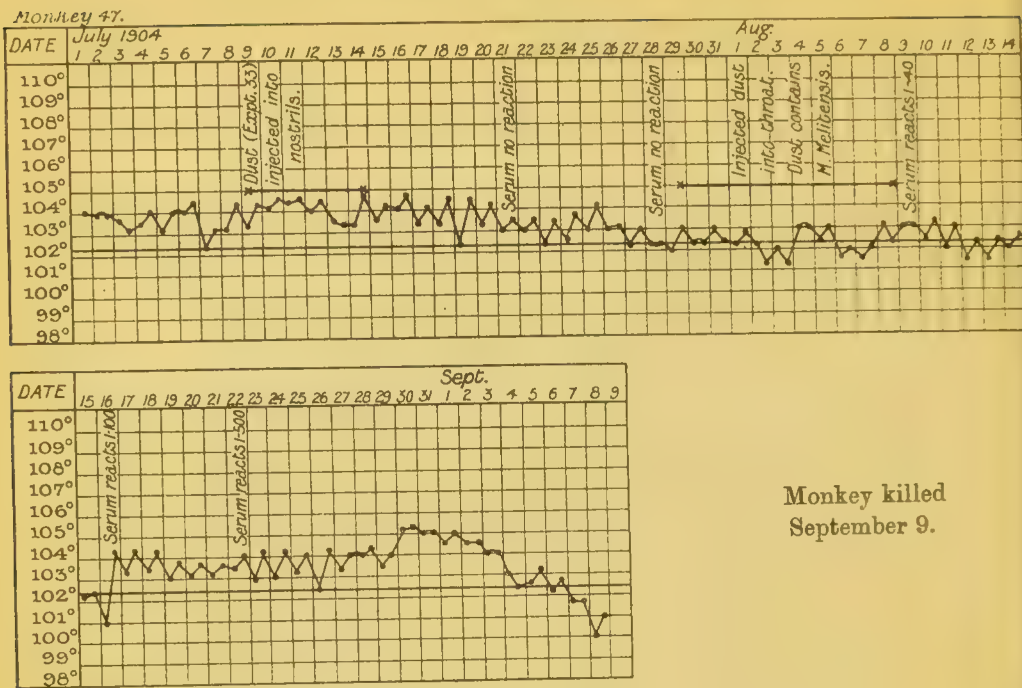
August 22, 1904. Examined blood, complete reaction at once 1—200; complete reaction, visible to naked eye in 10 minutes, dilution 1—500; 1—1000 dilution, *nil.*

September 9, 1904. This monkey has been very ill for some days, and has lost flesh rapidly. Being obviously in a dying state, he was killed with chloroform this morning. *Post-mortem* examination: Spleen enlarged, soft and friable. Kidneys markedly congested. Liver congested. Pericardium contained some fluid. Other viscera healthy

Made cultures from the spleen, kidneys and liver.

The *M. melitensis* was not recovered, as all the cultures proved to be contaminated. The monkey was dying, and a batch of broth, which had not been tested by incubation, had to be used; unfortunately, all the broth tubes were found, on incubation, to be contaminated by *B. mesentericus.*

The following chart represents the course of the temperature:—



Monkey killed September 9.

Monkey No. 47.

Result.—From this and the last experiment it is evident that the inhalation or swallowing of infected dust will give rise to Mediterranean Fever in monkeys.

Experiment III.—Monkey No. 39.

To determine if the Ingestion of Infected Food will give rise to Mediterranean Fever in Healthy Monkeys.

This monkey was kept under observation from July 1—10, 1904. It appeared perfectly healthy, and no cuts or abrasions were visible either on the body or in the mouth.

July 10, 1904. The growth from one agar slope, second generation, from spleen of man, and grown for 7 days at 37° C., was mixed with boiled potato, and eaten by the monkey.

July 11, 1904. The growth from one agar slope, as above, but grown for 8 days at 37° C., was mixed with boiled potato and two plums, and eaten by the monkey.

July 12, 1904. The same procedure followed, but the agar slope was 9 days old.

July 13, 1904. As on the 12th; growth 10 days old.

July 14, 1904. The same procedure followed, but a 9 days' old culture from heart's blood of a rabbit was employed.

July 15, 1904. Ten days' old culture, third generation, spleen of man used.

July 16, 1904. The same as on the 15th.
„ 18, „ „ „
„ 19, „ Feeding continued as on July 15, 1904.
„ 20, „ Feeding continued as on July 15, 1904. Examined blood, serum diluted 1—10, gave no reaction with the laboratory strain of *M. melitensis.*

July 21, 1904. Feeding continued. One agar slope, first generation, spleen H——, incubated for 7 days at 37° C., used.

July 22, 1904. Feeding continued. One agar slope, first generation, kidney H——, incubated for 8 days at 37° C., used.

July 23, 1904. The feeding was continued, but I omitted the plums from the mixture, as I found they gave rise to a strongly acid reaction which might inhibit or destroy the *M. melitensis.* One agar slope, first generation, kidney of H——, incubated for 9 days at 37° C., was employed.

July 25, 1904. Half an agar tube of third generation, spleen of H——, was given. The blood was examined for agglutination, but the serum, diluted 1—10, gave no reaction with the *M. melitensis.*

July 26, 1904. Half an agar tube of third generation, spleen of H——, incubated for 4 days at 37° C., was employed.

July 27, 1904. One agar slope, third generation, spleen of H——, incubated for 14 days at 37° C., mixed with potato.

July 28, 1904. One agar slope, fourth generation, spleen of H——, incubated for 5 days at 37° C., mixed with potato.

July 29, 1904. One agar slope, fourth generation, spleen of H——, incubated for 5 days at 37° C., mixed with potato.

July 30, 1904. One agar slope, fifth generation, spleen of H——, incubated for 5 days at 37° C., mixed with potato.

August 1, 1904. One agar slope, fifth generation, spleen of H——, incubated for 5 days at 37° C., mixed with potato.

August 2, 1904. One agar slope, fifth generation, spleen of H——, incubated for 5 days at 37° C., mixed with potato.

August 3, 1904. One agar slope, second generation, spleen of H——, incubated for 3 days at 37° C., mixed with potato. Only a small portion was consumed.

August 4, 1904. One agar slope, fourth generation, spleen of H——, incubated for 5 days at 37° C. Only a small portion was eaten.

August 5, 1904. One agar slope, second generation, from urine of Sergeant P——, and incubated 10 days at 37° C., mixed with potato.

August 6, 1904. One agar slope, third generation, spleen of H——, incubated for 72 hours at 37° C., mixed with potato.

August 8, 1904. One agar slope, third generation, spleen of H——, incubated for 6 days at 37° C., mixed with potato.

August 9, 1904. One agar slope, third generation, spleen of H——, incubated for 6 days at 37° C., mixed with potato.

August 10, 1904. One agar slope, third generation, spleen of H——, incubated for 15 days at 37° C., mixed with potato. Examined blood; serum reacts at once, visible to the naked eye, in a dilution of 1—80; under the microscope reaction is seen at once with a dilution of 1—160.

August 16, 1904. Examined blood; serum reacts at once, visible to the naked eye, dilution 1—100. Dilution 1—300 shows a reaction under $\frac{1}{12}$th.

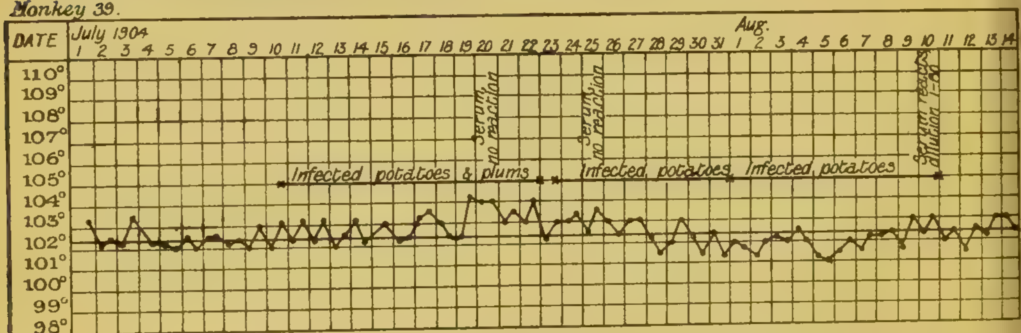
August 27, 1904. Examined blood; serum reacts at once, visible to the naked eye, dilution 1—100. After 5 minutes, dilution 1—500, is visible to the naked eye.

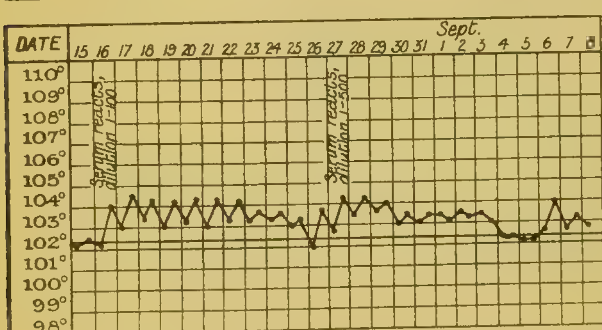
September 8, 1904. Killed the monkey with chloroform. Body well nourished. *Post-mortem.* Spleen enlarged, soft and friable. Kidneys congested Liver congested. Other viscera normal.

September 14, 1904. Recovered *M. melitensis* from the spleen.

The following chart represents the temperature curve:—

Monkey 39.





Monkey killed September 8.

Monkey No. 39.

Result.—The absorption of the *M. melitensis* was extremely slow, but the monkey eventually suffered from an acute infection.

Experiment IV.—Monkey No. 40.

To Determine if the Ingestion of Infected Food will give rise to Mediterranean Fever in Healthy Monkeys.

July 10, 1904. Half of the potato prepared for Monkey No. 39 was given to this monkey. The dose of *M. melitensis* corresponded to one agar slope, as in the case of Monkey No. 39.

July	11, 1904.	The same procedure was followed as in Experiment III, Monkey No. 39.
,,	12, ,,	,, ,, ,,
,,	13, ,,	,, ,, ,,
,,	14, ,,	,, ,, ,,
,,	15, ,,	,, ,, ,,
,,	16, ,,	,, ,, ,,
,,	18, ,,	,, ,, ,,
,,	19, ,,	,, ,, ,,
,,	20, ,,	,, ,, ,,
,,	21, ,,	,, ,, ,,
,,	22, ,,	,, ,, ,,
,,	23, ,,	,, ,, ,,
,,	25, ,,	The same procedure was followed as in Experiment III, Monkey No. 39. Examined blood; serum gave no reaction with *M. melitensis.*
,,	26, ,,	The same procedure was followed as in Experiment III, Monkey No. 39.
,,	27, ,,	,, ,, ,,
,,	28, ,,	,, ,, ,,
,,	29, ,,	,, ,, ,,
,,	30, ,,	,, ,, ,,
August	1, ,,	,, ,, ,,
,,	2, ,,	,, ,, ,,
,,	3, ,,	,, ,, ,,
,,	4, ,,	,, ,, ,,
,,	5, ,,	,, ,, ,,
,,	6, ,,	,, ,, ,,
,,	8, ,,	,, ,, ,,
,,	9, ,,	,, ,, ,,
,,	10, ,,	,, ,, ,,

,, 11, ,, Examined blood. Complete instantaneous agglutination, visible to the naked eye, dilution 1—30. After standing 5 minutes, dilution 1—100; was also visible to the naked eye.

August 20, 1904. Examined blood. Serum gave a reaction with *M. melitensis* when diluted 1—10, but no result was obtained with higher dilutions.

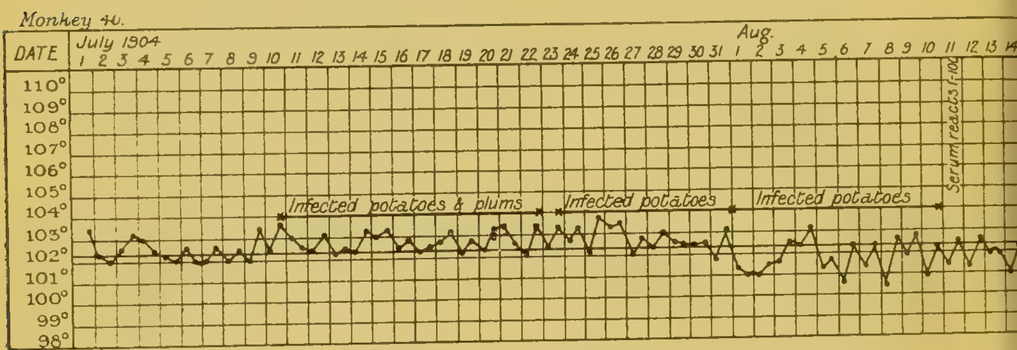
September 8, 1904. Monkey killed by chloroform. *Post-mortem :*

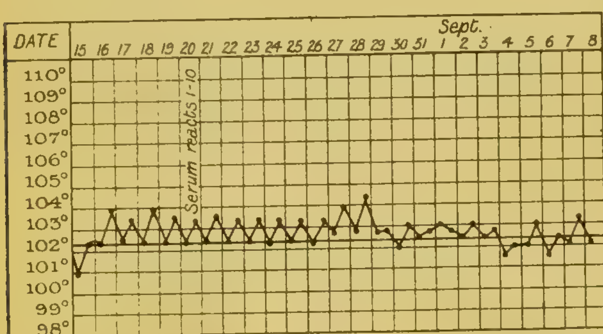
Spleen enlarged, but not so markedly as No. 39; kidneys congested; other viscera apparently healthy. Made cultures from the spleen, liver, and kidneys.

September 16, 1904. *M. melitensis* not recovered from the cultures made at the *post-mortem* examination. All the cultures proved to be sterile.

Note.—It seems probable that, in the case of this monkey, the bacterial infection was never marked, and that the few micrococci absorbed might easily have been destroyed.

The following chart represents the temperature curve:—





Monkey killed September 8.

Monkey No. 40.

Experiment V.—Monkey No. 66.

To determine if the Ingestion of Infected Food will give rise to Mediterranean Fever in Healthy Monkeys.

August 13, 1904. This monkey is in a box next to Monkey No. 39, and I noticed about a week ago that he ate some of the infected potato provided for No. 39. Examined blood, serum reacts instantaneously, visible to naked eye, dilution 1—100. Visible under $\frac{1}{12}$th after 10 minutes in a dilution of 1—500.

August 18, 1904. Believing this monkey to be healthy, Dr. Zammit, at 6.30 P.M. last evening, injected a small quantity of blood from a Mediterranean Fever patient. In order not to vitiate both experiments the monkey was killed at 11 this morning.

Post-mortem examination :—

Abdomen : Spleen enlarged and congested. Kidney enlarged and congested. Liver congested. Intestines appeared normal.

Thorax : Lungs healthy. Heart appeared dilated.

Cultures made as follows :—

Spleen : (*a*) Planted out in broth and (*aa*) rubbed over an agar slope.

(*b*) Kidney planted out in broth and (*bb*) rubbed over an agar slope.

(*c*) Liver planted out in broth.

(*d*) Heart's blood, planted out in two broth tubes.

(*e*) Urine, planted out in broth.

August 21, 1904. Typical colonies have appeared on the agar slope, made from the spleen ; fished one—it agglutinated at once with serum from Monkey No. 45.

August 22, 1904. Planted out colony from spleen on an agar slope.

" growth in broth, from heart's blood (two tubes), on an agar slope.

" growth in broth, from kidney, on an agar slope.

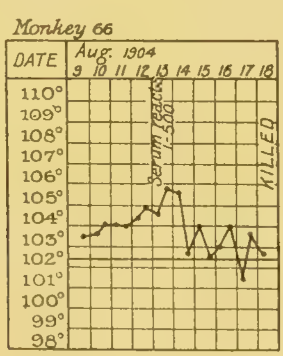
" growth in broth, from liver, on an agar slope.

August 24, 1904. Typical growth obtained from colony of spleen, planted out in litmus milk and glucose. Litmus milk rendered alkaline, glucose not fermented.

August 26, 1904. Typical growth, agglutinating at once with dilute serum, obtained from heart's blood.

August 28, 1904. Typical growth, agglutinating at once with monkey serum, obtained from kidney.

The following chart represents the temperature curve :—



Monkey No. 66.

Note.—This experiment is probably an instance of direct absorption of *M. melitensis* through a crack or abrasion of the mucous membrane of the mouth. The period of incubation and the wave of fever correspond exactly with those of Monkey No. 72, which was infected with

M. melitensis through a crack in the mucous membrane over the incisor teeth.

Experiment VI.—Monkey No. 72.

To Differentiate between Absorption from the Mouth and Throat and Absorption from the Stomach and Intestines.

Monkey No. 72 arrived in the laboratory on September 10, 1904. The blood was tested and gave no reaction with the *M. melitensis.* Feeding was then commenced, infected milk being passed directly into the stomach by means of an indiarubber tube. The growth on one agar slope, second generation, spleen of H——, incubated for 6 days at 37° C., was employed.

September 13, 1904. The feeding was continued as before, the growth on one agar slope, incubated for 7 days, being given. A small quantity of the milk regurgitated into the mouth, but no abrasion could be seen on the mucous membrane.

September 14, 1904. The growth from one agar slope, incubated for 8 days, was given.

September 15, 1904. The feeding was continued as before.

September 16, 1904. The feeding was continued, the growth from one agar slope, incubated for 5 days, being given. A little milk again regurgitated into the mouth, and, on examination, a small crack was found in the mucous membrane opposite the upper incisor teeth. The mouth was at once washed out with lysol. The blood was examined but no reaction with the *M. melitensis* was obtained.

September 17, 1904. The feeding was continued, the growth from one agar slope, incubated for 5 days, being given.

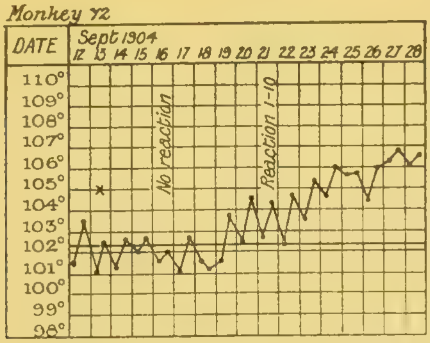
September 18, 1904. The growth from one agar slope, incubated for 6 days, was given.

September 21, 1904. The blood was examined and the serum in a dilution of 1—10, caused instantaneous clumping of the *M. melitensis.*

September 26, 1904. The serum, diluted 1—100, was found to agglutinate the *M. melitensis* instantaneously, the reaction being visible with the naked eye.

Note.—This monkey was directly infected either on September 13 or 16, the short incubation and sharp rise of temperature correspond to what is seen when the *M. melitensis* is directly absorbed into the peripheral circulation. Owing to the regurgitation of the infected milk into the mouth the experiment failed to differentiate between absorption from the mouth and from the alimentary canal; it, however, explains what probably occurred in the case of Monkey No. 66.

The prolonged incubation or rather slow absorption observed in the case of Monkeys Nos. 39, 40, and 41 forms a marked contrast to the rapid infection noticed in Monkeys Nos. 66 and 72, and approximates very closely to the results obtained when human beings are infected under natural conditions.



Monkey No. 72.

Experiment VII.—Monkey No. 45.

To note the Effect of the Subcutaneous Inoculation of M. melitensis *in Healthy Monkeys, and to Obtain a Specific Serum.*

July 9, 1904. Injected ½ c.c. of emulsion from an agar tube, second generation, from spleen of man. The agar tube was incubated for 6 days at 37° C., and the whole of the growth was used for the emulsion.

July 15, 1904. Complete agglutination with *M. melitensis* serum, diluted 1—10, and up to 1—160. No reaction with a dilution of 1—300.

July 21, 1904. Monkey looks ill. Tested serum—complete reaction, naked eye at once, dilution 1—1000. Shaved hair on back, and Zammit applied two female *Stegomyia*, which fed voraciously.

July 22, 1904. Zammit's feeding experiments with mosquitoes continued.

July 23, 1904. Zammit's feeding experiments with mosquitoes continued.

July 26, 1904. Tested serum; complete agglutination to naked eye, within 1 minute, dilution 1—1000.

August 1, 1904. Tested serum; complete agglutination to naked eye, within 1 minute, dilution 1—1000.

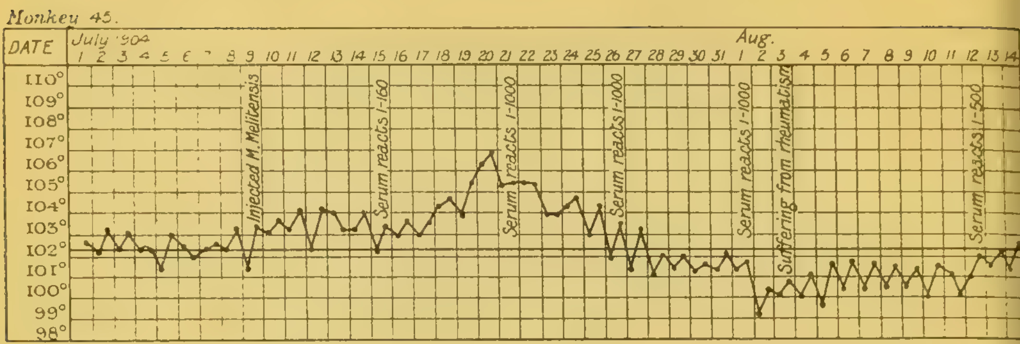
August 3, 1904. Monkey suffering from rheumatism (?); right arm and right wrist joint painful.

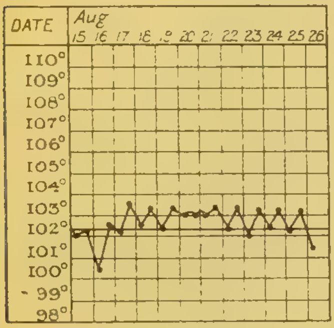
August 12, 1904. Examined blood; serum reacted at once, visible to naked eye, dilution 1—100; reaction after 5 minutes, dilution 1—500; dilution 1—1000, no reaction 5 minutes; feeble reaction, under microscope, after ½ hour.

September 9, 1904. Killed the monkey with chloroform. *Post-mortem*: Spleen much enlarged. Liver and kidneys congested. Other viscera healthy. Made cultures from the spleen, kidney and liver.

September 13, 1904. Recovered *M. melitensis* from spleen.

The following chart represents the temperate curve :—





Monkey No. 45.

Result.—The monkey suffered from a typical attack of Mediterranean fever.

Experiment VIII.—Monkey No. 48.

To Note the Effect of the Injection of Washings of Dust derived from Sergeants' Mess, Melleha Camp.

July 16, 1904. Dried soil (dust) from ventilation aperture, between W.C. and dining room of sergeants' mess at Melleha, received from Dr. Johnstone.

Soil macerated in sterile water, filtered, soil remaining washed, filtrate treated as follows:—10 c.c. injected into Monkey No. 48, subcutaneously between shoulders.

July 18, 1904. Ten cubic centimetres of further washings injected.

July 23, 1904. Examined blood; no reaction with *M. melitensis*, dilution 1—10.

August 11, 1904. Examined blood; no reaction with *M. melitensis*, dilution 1—10.

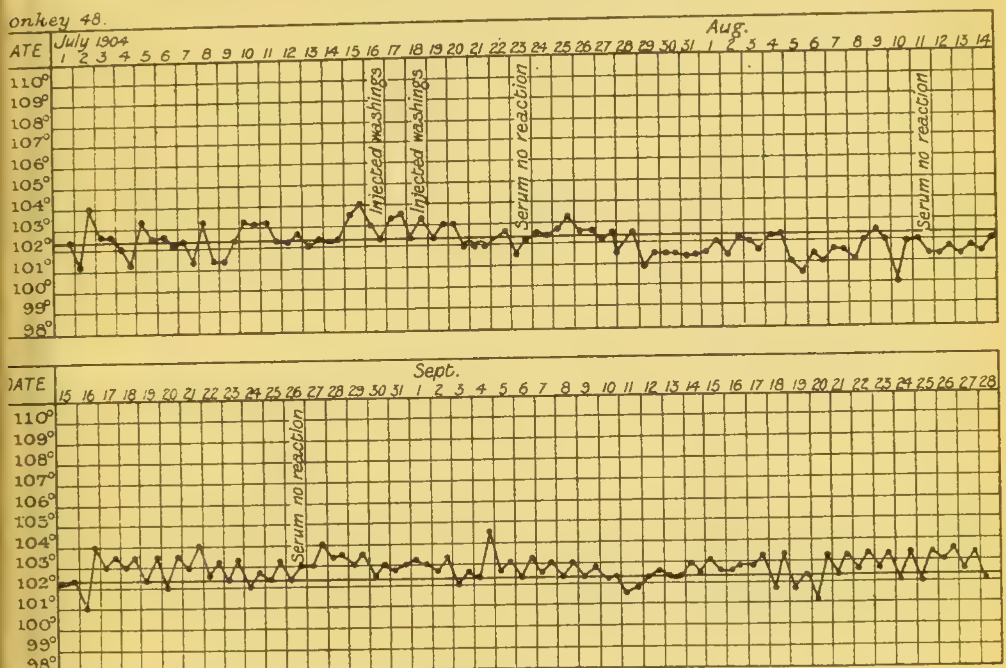
August 26, 1904. Examined blood; no reaction with *M. melitensis*, dilution 1—10.

September 6, 1904. Examined blood; no reaction with *M. melitensis*, dilution 1—10.

This experiment was performed at the request of Dr. Johnstone. The sergeants' mess at Melleha appeared to be the probable centre of infection of the sergeants of the Essex regiment. A disused W.C. was

found communicating by a ventilating aperture with the mess room. The dust was derived from this ventilating aperture.

The following chart represents the temperature curve :—



Monkey No. 48.

Result.—The *M. melitensis* was not present in the dust removed from the ventilating aperture.

Experiment IX.—Monkey No. 43.

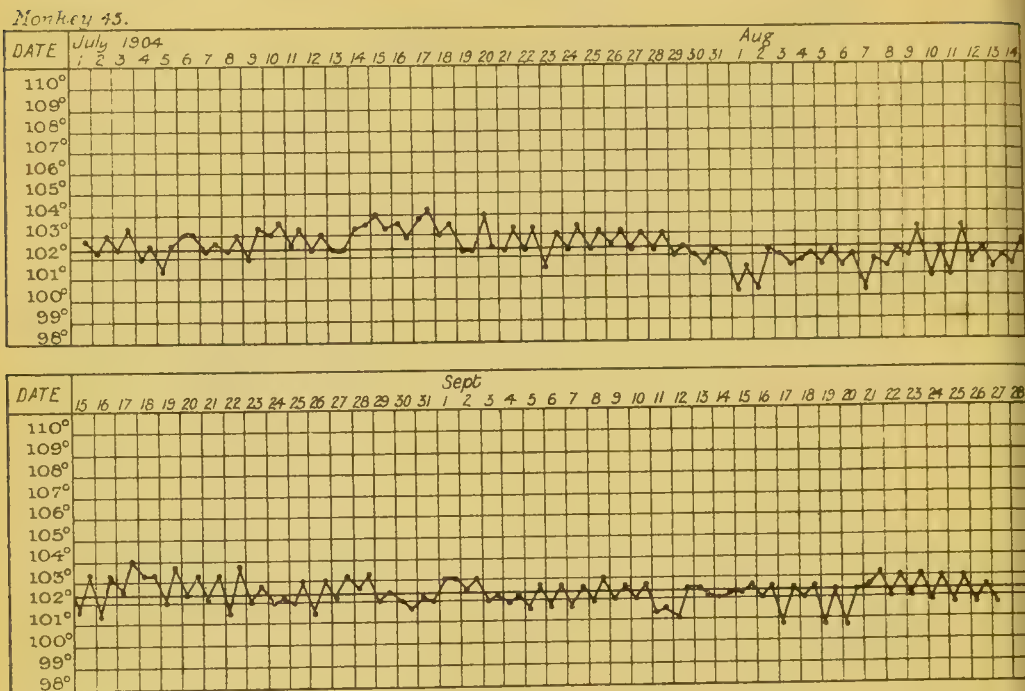
To Note the Effect of the Injection of Washings of Supposed Infected Soil into a Healthy Monkey.

July 16, 1904. Dr. Johnstone forwarded 0·14 gramme of soil, obtained from the pan of the disused W.C. in the sergeants' mess, Melleha Camp. The soil was macerated in sterile water, filtered through paper, and the deposit again thoroughly washed. The total filtrate obtained was 20 c.c. Of this 10 c.c. was injected subcutaneously into a monkey.

July 18, 1904. The remainder of the washings injected.

July	23, 1904.	Examined blood; serum, diluted 1—10, gave no reaction with *M. melitensis.*			
August	1,	,,	,,	,,	,,
,,	10,	,,	,,	,,	,,
,,	17,	,,	,,	,,	,,
,,	26,	,,	,,	,,	,,
September	6,	,,	,,	,,	,,

The following chart represents the temperature curve :—



Monkey No. 43.

Result.—The *M. melitensis* was not present in the soil removed from the W.C. in the sergeants' mess.

Experiment X. Monkey No. 46.

Injection of Washings from Wall of an Infected House.

July 7, 1904. The walls of the W.C., No. 26 Strada Nuova, Sliema, where two cases of Mediterranean Fever occurred, were rubbed with cotton wool moistened with saline solution; the water was expressed and filtered through paper. Filtrate, collected in a sterile tube, was treated as follows :—

Injected 10 c.c. of filtrate.

July 8, 1904. Injected 10 c.c. of filtrate.

July 9, 1904. " "

July 10, 1904. Injected the remaining portion (8 c.c.) of filtrate.

July 16, 1904. Examined blood, no reaction with *M. melitensis*, dilution 1—10.

July 18, 1904. Washings from kitchen, grown in broth for 11 days, injected to-day.

July 26, 1904. Tested serum, no reaction with *M. melitensis*, dilution 1—10.

August 10, 1904. Examined serum, no reaction with *M. melitensis*, dilution 1—10.

September 6, 1904. Examined blood; serum reacts at once with *M. melitensis*, dilution 1—10; reaction 1—500, after waiting 15 minutes.

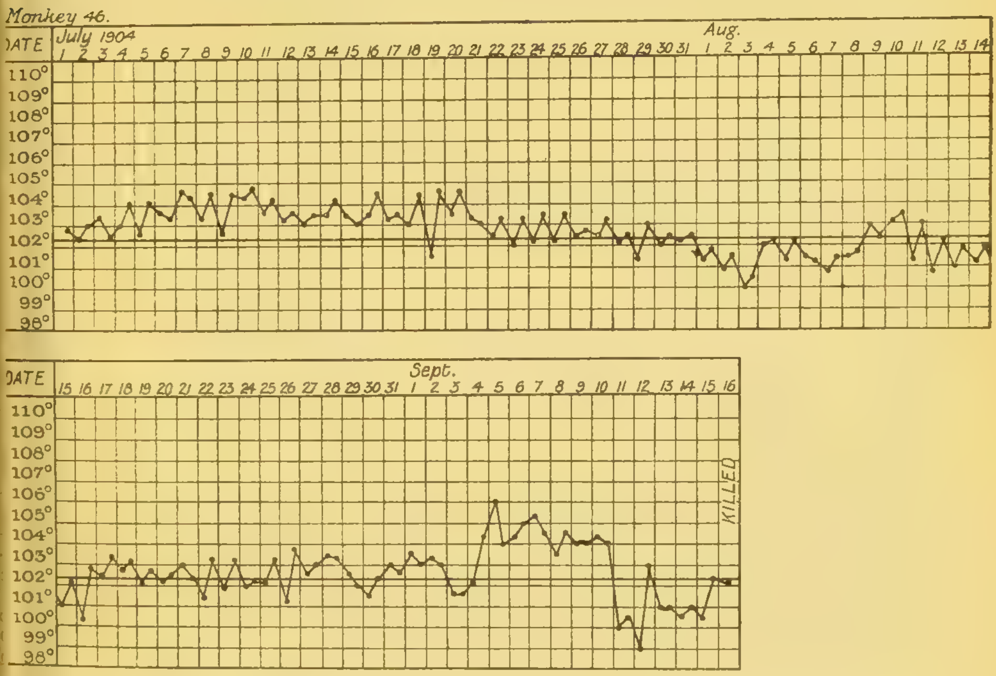
September 15, 1904. Examined blood; serum reacts at once in a dilution of 1—500; in a dilution of 1—1000 a reaction, visible to the naked eye, is seen in 5 minutes.

September 16, 1904. Killed the monkey with chloroform.

Post-mortem.—Spleen enlarged, but firm in consistence; kidneys and liver congested; pericardium contained a little fluid; other viscera healthy. Cultures made from spleen, liver, kidney, heart's blood, and urine.

September 23, 1904. *M. melitensis* isolated from spleen, kidney, and urine.

The following chart shows the temperature curve:—



Monkey No. 46.

Remarks.—This result is probably due to infection conveyed from neighbouring monkeys. Even if the *M. melitensis* had been present in the growth injected on July 18, it is highly improbable that the specific microbe when injected subcutaneously would have remained latent for a period of 50 days. Monkey No. 69 has also become infected since its arrival, without receiving the specific microbe either by the mouth or subcutaneously.

Monkey No. 46 on one side is next to Monkey No. 45, which received *M. melitensis* subcutaneously and developed a typical attack of fever.

On the other side of Monkey No. 46 is Monkey No. 47, infected by dust blown into the throat. Evidently this monkey has become infected, either by personal contact, by urine, or by means of *Stegomyia*.

Experiment XI.—Monkey No. 42.

To Determine if the Subcutaneous Injection of Infected Urine from a Case of Mediterranean Fever will give rise to the Disease in a Monkey.

July 13, 1904. Injected 10 c.c. of Howe's urine, enriched with broth, and incubated for 14 days at 37° C. (3 c.c. urine).

July 14, 1904. Injected 10 c.c. of Howe's urine (3 c.c. urine) treated as above, but incubated 15 days.

July 15, 1904. Injected 10 c.c. of mixed urine and broth (3 c.c. of urine), incubated 14 days.

July 18, 1904. Examined blood. Feeble reaction with one culture, blood diluted 1—10; tested with another culture, no reaction was obtained.

July 19, 1904. Injected 5 c.c. of broth culture, made at *post-mortem* of Howe by adding 1 c.c. of urine from bladder to broth, and then incubating at 37° C. for 12 days. Examined by hanging drop; fine cocci and chains, corresponding in morphology to *M. melitensis*, observed, the cocci decolorised by Gram.

July 20, 1904. Injected 10 c.c. of broth culture, made at *post-mortem* by adding contents of right ureter to a broth tube.

July 25, 1904. Examined blood; no reaction with *M. melitensis*, dilution 1—10.

August 2, " " " "

" 11, " " " "

" 26, " Examined blood; reacts 1—10 at once.

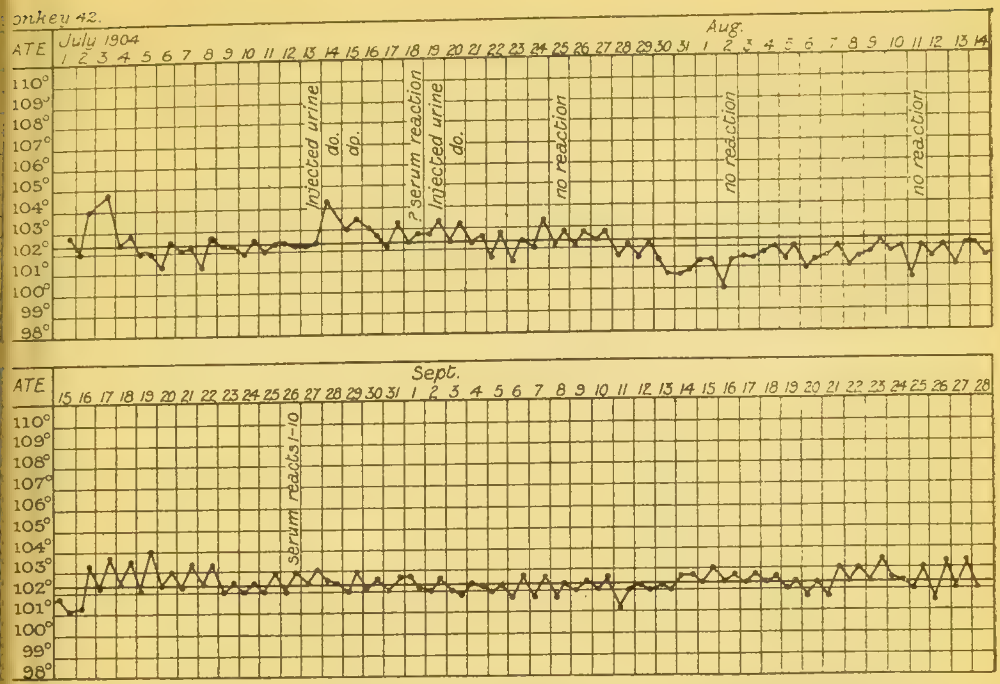
September 7, 1904. Examined blood; serum reacts in dilution of 1—20 at once: dilution 1—100, no reaction.

September 27, 1904. Killed monkey; made cultures from spleen, liver, kidney, heart's blood, and urine.

October 10, 1904. All the cultures have remained sterile.

Note.—The *M. melitensis* was recovered by plating another sample of the urine, removed from the bladder at the *post-mortem*.

The following chart shows the temperature curve; it will be noticed that there has never been a wave of fever, the slight serum reaction was probably caused by toxines contained in the urine :—



Monkey No. 42.

Remarks.—The *M. melitensis* was probably not present in the specimens of urine injected into this monkey. The slight blood reaction obtained might be caused by toxines in the urine.

Experiment XII.—Monkey No. 55.

To Determine whether Cultures of M. melitensis, *Derived from Infected Urine, will give Rise to the Disease in a Monkey.*

July 29, 1904. Growth from Pudney's urine, third generation, grown for 3 days on agar slope (glucose-litmus-nutrose-agar). The whole of the growth diffused in 2 c.c. of broth, and injected into this monkey.

August 4, 1904. Examined blood; complete instantaneous reaction, visible to naked eye, blood dilution 1—10; no reaction 1—50.

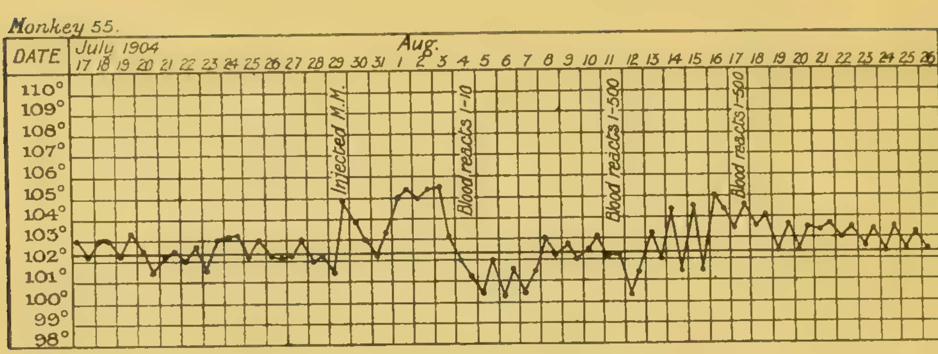
August 11, 1904. Examined blood; complete instantaneous reaction visible to naked eye, dilution 1—100; after 5 minutes, reaction visible in dilution 1—500.

August 17, 1904. Examined blood; reaction as on August 11, 1904.

September 8, 1904. Killed the monkey to-day. *Post-mortem*: Spleen enlarged and friable. Kidneys congested. Other viscera apparently healthy. Made cultures from the spleen, liver and kidneys.

September 12, 1904. *M. melitensis* recovered from the spleen.

The following chart shows the temperature curve:—



Monkey No. 55.

Result.—This experiment shows that the *M. melitensis* recovered from the urine of Mediterranean Fever patients is capable of giving rise to the disease in healthy monkeys.

Experiment XIII.—Monkey No. 69.

Is Mediterranean Fever Conveyed from Diseased to Healthy Monkeys by Contact?

This monkey arrived in the laboratory on August 7, 1904. It was placed in a cage, between Monkey No. 41, infected by dust, and Monkey No. 40, infected by feeding. Monkey No. 69 appeared perfectly healthy on arrival, and ate well; its temperature was taken from August 9, and after August 16 displayed an erratic course, probably accounted for by the intense heat of the terrace from early morning until evening.

On August 26, 1904, the blood was examined, but the serum, diluted 1—10, gave no signs of reaction with *M. melitensis.*

On September 7, 1904, the blood was again examined, and the serum, diluted 1—10, caused immediate clumping of the *M. melitensis*, visible to the naked eye.

Since September 9, 1904, the monkey has been obviously ill, losing flesh and sitting "moping" in his box all day.

On September 11, 1904, the serum, diluted 1—20, caused instantaneous clumping of the *M. melitensis.*

On September 13, 1904, the monkey died, much emaciated.

Post-mortem examination: All the viscera appeared healthy; cultures were made from the spleen, liver, kidneys, heart's blood and urine. *M. melitensis* isolated from the spleen and liver.

Remarks as to the Mode of Infection of this Monkey.—It seems possible that it might have occurred in three ways, *i.e.* (*a*) by direct personal contact; (*b*) by direct infection from walking in the infected urine of his neighbours; (*c*) by means of *Stegomyia.* When at full

length of his chain, Monkey No. 69 could touch either of his neighbours and walk on the ground infected by them.

If personal contact alone had been the cause of infection, Monkey No. 48 ought to have been infected by Monkey No. 47. Also the *M. melitensis* has not yet been isolated from the sweat or skin scrapings of patients suffering from Mediterranean fever.

If the infection had been carried by *Stegomyia*, there should have been a general infection amongst the monkeys on the terrace. There appears no reason why mosquitoes should have picked out Monkey No. 69 and Monkey No. 46, which also appears to have been infected by its neighbours. At this time there were six other healthy monkeys on the terrace exposed to the bites of mosquitoes, and one of them, No. 48, was in a cage next to an infected monkey. Yet none of these monkeys have shown the slightest trace of a blood reaction. Direct infection through infected urine seems to be the most probable explanation of the infection. Both Monkey No. 69 and Monkey No. 46 had infected monkeys next to them, and the chance of infection from urine was undoubted, as the *M. melitensis* was discovered in the urine of Monkey No. 46, proving that the specific microbe is excreted from monkeys in the same manner as from human beings. Although the cages and cemented surfaces beneath them were washed with lysol night and morning, still the ground was often noticed covered with decomposing urine.

Having in view the possibility of direct infection from urine excreted by monkeys suffering from Mediterranean fever, it is necessary to enquire whether any of the experiments previously recorded are invalidated by this circumstance. It will be advisable to discuss the experiments *seriatim*.

Experiment I, Monkey No. 41.—This monkey was kept in a small room on the left of the door leading from the laboratory to the roof. It was not placed in its box until infection had been acquired, and even after this it was still separated from Monkey No. 40 by a healthy monkey. It is evident that in relation to this experiment the question of infection by urine could not arise.

Experiment II, Monkey No. 47.—This monkey was placed between two healthy monkeys, viz., No. 46 and No. 48. Monkey No. 48 remained in good health throughout the summer and never showed the slightest sign of infection. Monkey No. 47 was infected on August 8, 1904, but Monkey No. 46 did not show a reaction until September 6, 1904. It is obvious that Monkey No. 47 could not have been infected by urine excreted by its neighbours.

Experiment III, Monkey No. 39.—The monkey was placed between Monkey No. 58 and Monkey No. 66. Monkey No. 58 only received injections of filtered toxines, and could not possibly excrete the specific micrococci in its urine. Monkey No. 66 was directly infected through

a crack in the mouth, and suffered from a marked bacterial infection; its first rise of temperature occurred on August 10, 1904, and it is practically impossible that the *M. melitensis* could have been excreted in its urine before this date, and, taking into consideration the facts observed in man, it is unlikely that the urine would contain the *M. melitensis* before August 25, 1904. Consequently it seems impossible that the Monkey No. 39 could have received infection from the urine of its neighbours.

Experiment IV, Monkey No. 40.—This monkey was infected on August 11, 1904, and the monkeys nearest to it, viz., 69 and 41, were not infected until September 7, 1904, August 26, 1904, respectively. The question of infection by urine could not arise in this case.

Experiment V, Monkey No. 66.—This monkey was placed between Monkey No. 67 and Monkey No. 39. Monkey No. 67 never showed the slightest trace of infection, and was in good health all the summer. Monkey No. 39, as previously stated, was infected about the same date as Monkey No. 66. It does not seem possible that infection by urine could have played a part in this experiment.

Experiment VI, Monkey No. 72.—This monkey was directly infected through a crack in the mucous membrane of the mouth on September 13 or 16. It was kept apart from infected monkeys.

Experiment VII, Monkey No. 45.—This monkey was directly infected by subcutaneous injection of the *M. melitensis.*

Experiment VIII, Monkey No. 48 } These monkeys failed to become
Experiment IX, Monkey No. 43 } infected.

Experiment X, Monkey No. 46.—This monkey was infected on September 6, 1904, and it appears practically certain that the infection was caused by the specific micrococci present in the urine of neighbouring monkeys.

Experiment XI, Monkey No. 42.—This monkey probably only received toxines contained in the urine excreted by a case of Mediterranean fever.

Experiment XII, Monkey No. 55.—This monkey was directly infected by the subcutaneous injection of the *M. melitensis.*

Experiment XIII, Monkey No. 69.—This monkey became infected on September 7, 1904. The source of infection was probably the urine of its neighbours.

List of Monkeys, not infected, artificially infected, and naturally infected, with Dates of Arrival and Infection.

No.	Infection.	Arrival.	Remarks.
70.	Not infected.	8/8/04.	
65.	"	"	Dr. Zammit's mosquito experiments.
64.	"	"	" "
63.	Artificially infected.	"	" "
62.	Not infected.	16/7/04.	
61.	"	"	
60.	"	"	Died, diarrhœa, 26/8/04.
59.	"	"	Died 11/9/04.
49.	"	8/8/04.	
48.	"	1/7/04.	
47.	Artificially infected 9/8/04.	"	Died. Experiment II, page 48.
46.	Naturally infected 6/9/04.	"	
45.	Artificially infected 15/7/04.	"	Subcutaneous injection 9/7/04.
44.	Not infected.	"	Died from pneumonia, 6/7/04.
43.	"	"	
42.	(?) Infected (probably toxine)	"	Urine infection.
67.	Not infected.	8/8/04.	Mosquito experiment.
66.	Artificially infected ? 9 or 10/8/04.	"	Food experiment. Serum 13/8/04.
39.	Artificially infected 10/8/04.	1/7/04.	Food experiment.
58.	Not infected.	16/7/04.	Toxine injected.
57.	"	"	Died from diarrhœa 15/8/04.
56.	"	"	" 5/8/04.
55.	Infected 4/8/04.	"	Culture from urine. Serum 4/8/04.
54.	Not infected.	"	Skin scraping.
68.	"	8/8/04.	"
40.	Artificially infected 11/8/04.	1/7/04.	Experiment IV, page 53.
69.	Naturally infected 7/9/04.	8/8/04.	
41.	Artificially infected 26/8/04.	8/7/04.	Died. Experiment I, page 46.

Mosquito Experiments.

These experiments were undertaken in order to ascertain whether the *Stegomyia fasciata* is able to convey the *M. melitensis* from the peripheral blood of Malta Fever patients to healthy monkeys.

Experiment I.

In this experiment the mosquitoes were fed on Private Lawrence, 2nd Essex Regiment. This particular patient was selected, as Staff-Surgeon Shaw had found the maximum number of micrococci in his blood. The number of mosquitoes and the dates on which they were

fed on the patient and on Monkey No. 70, are shown in Table I. An endeavour was made to keep the mosquitoes alive as long as possible, as in view of the work done on Yellow Fever it seemed possible that several days might intervene between the absorption of the *M. melitensis* into the stomach of the mosquito and its transfer, possibly through the salivary glands, to the proboscis. In Dr. Zammit's successful experiment only 48 hours intervened between the absorption of the micrococci and their transfer to the patient. In Experiment I the intervals were 2, 4, 8, and 10 days, respectively. Monkey No. 70 had been under observation for several months and always appeared perfectly healthy. Its serum was examined at varying periods, but it never manifested the slightest power of agglutinating the *M. melitensis.*

Experiment II.

The same procedure was followed in this experiment, the patient, Private K——, R.A.M.C., having a typical wave of fever. The number of mosquitoes and the dates when they were fed on the patient and on Monkey No. 44, are given in Table II. The mosquitoes were kept alive for 13 days, and yet no trace of agglutination could be detected when the serum of the monkey, in a low dilution, was added to an emulsion of the *M. melitensis.*

Experiment III.

In this experiment mosquitoes were fed on different patients, specially selected owing to the presence of marked fever at the time of feeding. The details of the various feedings are given in Table III. All the agglutination tests were negative.

Experiment IV.

In this experiment mosquitoes were fed on monkeys recently inoculated with *M. melitensis* and, after an interval of 48 hours, transferred to Monkey No. 76 which arrived at the laboratory on 8.9.04. On 16.9.04 and 22.9.04 the serum of Monkey 76, diluted 1—10, was added to an emulsion of *M. melitensis;* no agglutination was observed on either occasion. On the 20.9.04 mosquitoes were fed on Monkey No. 60A, at that time at the summit of a wave of fever, and 48 hours later they were fed on Monkey No. 76. On the 25.9.04, mosquitoes were again fed on Monkey No. 60A, and on the 27.9.04 transferred to Monkey No. 76. On the 27.9.04 mosquitoes were fed on Monkey No. 72, infected by feeding and at the height of a wave of fever, and 48 hours later transferred to Monkey No. 76. The serum of Monkey No. 76 was examined on 27.9.04, but did not manifest the slightest power of agglutinating the *M. melitensis.*

(These experiments are still proceeding.)

Table I.—Monkey No. 70. Mosquito Experiments (continued up to the end of October).

Mosquitoes fed on patient.		Mosquitoes fed on monkey.																																								No. of times each mosquito fed on monkey.
		No. of days after being fed on patient.																																								
Date.	No. of mosquitoes.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
1904.																																										
Sept. 6..	2 { 1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	1	..	1	..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
" 9..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
" 10..	1	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
" 17..	2 { 1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	1	..	1	..	1	..	1	..	1	..	1	..	1	..	..	..	1	..	..	1	..	1	..	1	..	..	1	..	1	..	1	..	..	1	..	1	..	1	..	1	..	17

The monkey was bitten 24 times by presumably infected mosquitoes, and, in the case of one mosquito, 39 days intervened between the first feeding on the patient and the last feeding on the monkey. The serum was repeatedly examined, but never caused the slightest agglutination of the *M. melitensis*.

Table II.—Monkey No. 44. Mosquito Experiments (continued up to the end of October).

Mosquitoes fed on patient.		Mosquitoes fed on monkey.																					No. of times each mosquito fed on monkey.
		No. of days after being fed on patient.																					
Date.	No. of mosquitoes.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1904. Aug. 29..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
,, 31..	2 { 1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
Sept. 14..	4 { 1	..	1	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
	1	..	1	..	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	4
	1	..	1	..	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	4
	1	..	1	..	..	1	..	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	6
,, 17..	2 { 1	..	1	..	..	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	4
	1	..	1	..	1	..	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	6
Oct. 5..	2 { 1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	1	..	1	..	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	5
,, 5..	4 { 1	..	1	..	..	..	1	..	1	..	1	..	..	1	..	1	..	1	..	1	..	..	8
	1	..	1	..	1	..	1	..	1	..	1	..	1	..	..	1	..	1	..	1	..	..	9
	1	..	1	..	1	..	1	..	1	..	1	..	1	..	..	1	..	1	..	1	..	1	10
	1	..	1	..	1	..	1	..	1	..	1	..	1	..	..	1	..	1	..	1	..	1	10
,, 5..	2 { 1	..	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	4
	1	..	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	4
,, 24..	4 { 1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2
	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3
	1	..	1	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3

This monkey was bitten 92 times by presumably infected mosquitoes, and in the case of two mosquitoes 21 days intervened between the first feeding on the patient and the last feeding on the monkey. Its serum was repeatedly examined, but never caused the slightest agglutination of the *M. melitensis*.

Table III.—Monkey No. 56. Mosquito Experiments (continued up to the end of October).

Mosquitoes fed on patients.		Mosquitoes fed on monkey.																						Number of times each mosquito fed on monkey.
		Number of days after being fed on patient.																						
Date.	No. of mosquitoes.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
1904. Sept. 4	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
,, 16	3 { 1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
,, 22	1	...	...	1	...	1	...	...	1	...	...	1	...	...	1	...	1	...	1	...	1	...	1	9
,, 23	4 { 1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	1	...	1	...	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	4
	1	...	1	...	1	...	...	1	...	...	1	...	...	1	...	1	...	...	...	...	...	...	...	6
,, 25	3 { 1	...	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
,, 26	4 { 1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1
	1	...	...	1	...	...	...	1	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	4
Oct. 10	6 { 1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
	1	...	1	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
	1	...	1	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
	1	...	1	...	1	...	1	...	1	...	1	...	1	...	...	...	...	...	...	...	...	...	...	6
	1	...	1	...	1	...	1	...	1	...	1	...	1	...	1	...	1	...	...	...	...	...	...	8
	1	...	1	...	1	...	1	...	1	...	1	...	1	...	1	...	1	...	1	...	...	1	...	10
,, 19	4 { 1	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
	1	...	...	1	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2
	1	...	...	1	...	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	5
	1	...	...	1	...	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	5
,, 24	4 { 1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3
	1	...	1	...	1	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	3

Monkey No. 56 was bitten 101 times by presumably infected mosquitoes. Its serum was repeatedly tested as to agglutination of the *M. melitensis*, but no signs of a reaction were observed.

The want of success, which has up to the present attended our efforts to transfer by means of mosquitoes the *M. melitensis* from infected human beings to healthy monkeys, is disappointing but does not necessarily invalidate the result obtained by Dr. Zammit. The case upon which he made his successful experiment was unusually severe, and since then cases of this type have not been met with either in the military or in the civil hospitals.

Conclusions drawn as to the Mode of Entrance of the M. melitensis *into the Body.*

There is experimental evidence to show that the *M. melitensis* when present in dry dust is capable of being absorbed by monkeys.

The path of absorption may be through the nares, throat, respiratory passages, and alimentary canal. When present in food it is also taken into the system of monkeys; here, again, the path of absorption may be through the throat as well as through the mucous membrane of the alimentary canal.

When transmitted through an unbroken mucous membrane the process of absorption is comparatively slow, and under these conditions the wave of fever appears to be prolonged. The long and variable incubation period observed in monkeys infected through an unbroken mucous membrane is frequently observed in man infected under natural conditions.

When the *M. melitensis* is absorbed through a crack in a mucous membrane or in the skin, or is injected subcutaneously, the absorption is rapid and the incubation period in monkeys varies from 5 to 7 days. The curve of fever is characterised by a rapid rise usually followed by a rapid fall. These acute infections have also been observed in man infected under the same conditions, but the period of incubation appears to be longer in man than in the monkey.

The history of Monkeys Nos. 69 and 47 shows that healthy monkeys may become infected by urine secreted by monkeys suffering from Mediterranean Fever. Just as in the case of man, the *M. melitensis* is excreted in the urine of infected monkeys. And it seems probable that healthy monkeys walking in the infected secretion convey the specific microbe into the mouth by means of the paws.

Infection by means of urine secreted by cases of Mediterranean Fever readily explains the cases of Mediterranean Fever which appear to arise spontaneously in hospitals. In the absence of specific knowledge as to the mode of excretion of the *M. melitensis* from the human body, sufficient care has hitherto not been taken to sterilise bed-pans, urine bottles and sheets soiled by cases of Mediterranean Fever.

There is no evidence that Mediterranean Fever can be contracted by contact with cutaneous surfaces, uncontaminated by urine.

The experiments made with *Stegomyia fasciata* do not support the result obtained by Dr. Zammit.

5.

DESCRIPTION OF A METHOD OF CULTIVATING THE *MICROCOCCUS MELITENSIS* FROM SMALL QUANTITIES OF PERIPHERAL BLOOD AND INOCULATION EXPERIMENTS WITH THE MICRO-ORGANISMS ISOLATED.

By Staff-Surgeon R. T. Gilmour, R.N., Bighi Hospital, Malta.

[*Note.*—This work was kindly undertaken by Staff-Surgeon Gilmour, R.N., at the laboratory of the Naval Hospital, Malta. He has already published a paper on the subject entitled "A few Notes on the Bacteriology and Pathology of Mediterranean Fever," published in 'Health of the Navy' for 1902. In that paper he gives the result of the examination of sixteen cases of Mediterranean Fever. Out of these sixteen cases the *M. melitensis* was isolated from eight, three gave no growth, and five were uncertain as they were contaminated. In these first experiments Staff-Surgeon Gilmour used fairly large quantities of blood and incubated the blood in a large volume of broth. From 0·5—8·8 c.c. blood in from 15—60 c.c. of broth were used.—Ed.]

Preparation of the Patient.

The arm should be chosen in which the veins at the bend of the elbow are the most prominent. The selected limb should be shaved from the middle of the arm to the middle of the forearm. This area should then be washed with hot sterile water, carbolic soap, and a sterile nail-brush for 20 minutes; then swabbed with ether for 10 minutes, to dissolve out the fat, and finally scrubbed with a 1 in 500 solution of perchloride of mercury for $\frac{1}{4}$ hour. A sterile dressing should then be applied, soaked in the same disinfectant, until the time of the operation, about 24 hours afterwards.

The Apparatus Required.

1. A sterile bandage.
2. A sterile 10 c.c. serum syringe.

3. (*a*) One flask, containing 30 c.c. of broth.
   (*b*) Two tubes, each containing 9 c.c. of broth.*
   (*c*) Sufficient Petri's dishes, each containing 10 c.c. of agar-agar.
4. A spirit lamp.
5. Sterile 1 c.c. pipettes and glass rods.
6. Six tubes, each containing 10 c.c. of broth.

Method of Extracting the Blood.

1. Remove the bandage from the dressing.

2. Constrict the arm above the elbow-joint with the sterile bandage.

3. After waiting a few minutes, so that the veins may become engorged, insert the needle into the most prominent vein and withdraw sufficient blood, about 5 c.c.

4. An assistant, holding the flask and the tubes on the slant, should then remove the plugs with sterile forceps, and the required quantities of blood (2 c.c. for the flask, and 1 c.c. for the two 9 c.c. tubes) should be passed into the broth.

The assistant should then keep the broth in the tubes well agitated, so as to prevent coagulation and get a good emulsion.

0·5 c.c. of blood should then be passed into each of the Petri dishes, and immediately spread out with a sterile rod.†

5. The next part of the procedure must be performed in the laboratory. Pass the following quantities of emulsion, from one of the 9 c.c. tubes, into others containing 10 c.c. of broth:—‡

0·1 c.c. of emulsion	=	(0·01 c.c. of blood)	into the	1st	tube.
0·25 ,, ,,	=	(0·025 ,, ,,)	,,	2nd	,,
0·5 ,, ,,	=	(0·05 ,, ,,)	,,	3rd	,,
1·0 ,, ,,	=	(0·1 ,, ,,)	,,	4th	,,
2·0 ,, ,,	=	(0·2 ,, ,,)	,,	5th	,,
3·0 ,, ,,	=	(0·3 ,, ,,)	,,	6th	,,

6. Incubate the broth tubes and Petri's dishes at 35° C., and examine daily. From the 4th to 10th day of incubation inoculate sloped agar tubes from the broths, allowing 15 drops to flow over the surface of each. Ring all colonies daily, which appear in the Petri dishes, and number them, keeping a tally of the day they appeared. From the 4th to the 10th day remove the colonies with a sterile loop, plant on agar, and incubate at 35° C.

The following are the tests applied to ascertain whether a growth is *M. melitensis*:—

* Tubes containing 19 c.c. of broth were afterwards used.
† These dishes were afterwards inoculated with 1 c.c. of 1–10 emulsion.
‡ Smaller quantities of blood were afterwards used.

1. An emulsion in normal saline is examined under the microscope.
2. Specimens are stained with Neelson's carbol-fuchsine (1 in 10).
3. Specimens are stained by Gram's method.
4. The growth is tested for agglutination with the sera of Mediterranean fever cases; controls being made with healthy serum.

The reaction of all media used in the experiments is + 10A (Eyre's scale) unless otherwise stated.

Experiment I.

Harry Chapman, 28. Admitted into hospital on April 2, 1904. On June 23, 1904, the 84th day of illness, 8·0 c.c. of blood were withdrawn from the left median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
4·0 c.c.	30 c.c.	Pure culture of *M. melitensis.*
1·0 ,,	10 ,,	,, ,,
1·0 ,,	9 ,,	Used for inoculating the following tubes.
0·01 ,,	10 ,,	Negative.
0·025 ,,	10 ,,	,,
0·5 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·2 ,,	10 ,,	,,
0·3 ,,	10 ,,	,,

Result of Inoculations of Blood on to Sloped Agar Tubes.

Amount of blood used.	Amount of medium used.	Result.
0·5 c.c.	10 c.c.	One colony of *M. melitensis.*
,,	,,	Three colonies of *M. melitensis.*
,,	,,	Sterile.

Experiment II.

J. S. Ward, 24. Admitted into hospital on June 8, 1904. On June 25, 1904, the 17th day of illness, 5·0 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
2·0 c.c.	30 c.c.	Contaminated.
1·0 ,,	9 ,,	The *M. melitensis* obtained.
0·01 ,,	10 ,,	Sterile.
0·025 ,,	10 ,,	,,
0·05 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·2 ,,	10 ,,	The *M. melitensis* obtained.
0·3 ,,	10 ,,	Sterile.

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·5 c.c.	10 c.c.	Five colonies of *M. melitensis* obtained.
0·25 ,,	10 ,,	Contaminated.

Experiment III.

Alfred Law, 20. Admitted into hospital on June 20, 1904. On June 28, 1904, the 14th day of illness, 5·0 c.c. of blood were withdrawn from the left median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
2·0 c.c.	30 c.c.	Contaminated.
0·01 ,,	10 ,,	Sterile.
0·025 ,,	10 ,,	*M. melitensis* obtained.
0·5 ,,	10 ,,	,, ,,
0·1 ,,	10 ,,	,, ,,
0·2 ,,	10 ,,	,, ,,
0·3 ,,	10 ,,	,, ,,
0·01 ,,	10 ,,	,, ,,
0·025 ,,	10 ,,	,, ,,
0·05 ,,	10 ,,	,, ,,
0·1 ,,	10 ,,	,, ,,
0·2 ,,	10 ,,	Broth contaminated.
0·3 ,,	10 ,,	,, ,,

Experiment IV.

John Waters, 23. Admitted into hospital on June 29, 1904. On July 5, 1904, the 25th day of illness, 8·0 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
2·0 c.c.	30 c.c.	The *M. melitensis* obtained.
1·0 ,,	9 ,,	Sterile.
0·01 ,,	10 ,,	,,
0·025 ,,	10 ,,	,,
0·05 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·2 ,,	10 ,,	,,
0·3 ,,	10 ,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·5 c.c.	10 c.c.	One colony of *M. melitensis.*
,,	,,	,, ,,
,,	,,	Contaminated.
,,	,,	Two small contaminations. No *M. melitensis.*
,,	,,	One small contamination. No *M. melitensis.*

Experiment V.

Thomas Eccles, 23. Admitted into hospital on July 9, 1904. On July 19, 1904, the 23rd day of illness, 2·0 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
0·01 c.c.	10 c.c.	Contaminated.
0·025 ,,	,,	,,
0·05 ,,	,,	,,
0·2 ,,	,,	,,
0·2 ,,	,,	,,

Result of Inoculations of Blood on to Sloped Agar Tubes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	Contaminated.
,,	,,	,,
,,	,,	,,
,,	,,	,,
,,	,,	,,

The whole of these growths were contaminated with a staphylococcus.

Experiment VI.

Edward Stedman, 32. Admitted into hospital on July 7, 1904. On July 20, 1904, the 25th day of illness, 3·5 c.c. of blood were withdrawn from the left median-basilic vein.

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	One colony of *M. melitensis*.
,,	,,	Sterile.
,,	,,	Contaminated.
,,	,,	Sterile.

Experiment VII.

Sidney Fleetwood, 23. Admitted into hospital on June 11, 1904. On July 21, 1904, the 40th day of illness, 4·0 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
1·0 c.c.	50 c.c.	Pure culture of *M. melitensis*.
0·01 ,,	10 ,,	Sterile.
0·025 ,,	10 ,,	,,
0·05 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·2 ,,	10 ,,	,,
0·3 ,,	10 ,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	Sterile.
,,	,,	,,
,,	,,	,,
,,	,,	,,
,,	,,	One colony of *M. melitensis*.

Experiment VIII.

James Slater, 21. Admitted into hospital on July 13, 1904. On July 22, 1904, the 20th day of illness, 3·5 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
1·5 c.c.	30 c.c.	Pure culture of *M. melitensis.*
0·005 ,,	10 ,,	Sterile.
0·0125 ,,	10 ,,	,,
0·025 ,,	10 ,,	,,
0·05 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·15 ,,	10 ,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	Sterile.
,,	,,	Contaminated.
,,	,,	Sterile.
,,	,,	Contaminated.
,,	,,	,,
,,	,,	Sterile.

Experiment IX.

Arthur Witte, 27. Admitted into hospital on August 9, 1904. On August 12, 1904, the 3rd day of illness, 3·5 c.c. of blood were withdrawn from the left median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
1·0 c.c.	30 c.c.	Pure culture of *M. melitensis* obtained.
0·005 ,,	10 ,,	Sterile.
0·0125 ,,	10 ,,	,,
0·025 ,,	10 ,,	,,
0·05 ,,	10 ,,	,,
0·1 ,,	10 ,,	,,
0·15 ,,	10 ,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	One colony of *M. melitensis*, and one small colony of contamination.
,,	,,	One small colony of contamination.
,,	,,	Sterile.
,,	,,	Contaminated.
,,	,,	,,
,,	,,	,,

Experiment X.

Arthur Witte, 27. Admitted into hospital on August 9, 1904. On August 19, 1904, the 10th day of illness, 2·5 c.c. of blood were withdrawn from the right median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
0·005 c.c.	10 c.c.	Sterile.
0·0125 ,,	,,	Contaminated.
0·025 ,,	,,	,,
0·05 ,,	,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	Sterile.
	,,	One small colony of contamination.
,,	,,	Contaminated.

Experiment XI.

Frank Murch, 26. Admitted into hospital on August 14, 1904. On August 19, 1904, the 5th day of illness, 1·0 c.c. of blood was withdrawn from the left median-basilic vein.

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	31 colonies of *M. melitensis*.
,,	,,	33 ,, ,,
,,	,,	31 ,, ,,

Experiment XII.

Edward Freak, 21. Admitted into hospital on August 18, 1904. On August 22, 1904, the 24th day of illness, 1·0 c.c. of blood was withdrawn from the left median-basilic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
0·005 c.c.	10 c.c.	Sterile.
0·0125 ,,	,,	,,
0·025 ,,	,,	Contaminated.
0·05 ,,	,,	Sterile.
0·1 ,,	,,	,,

Experiment XIII.

Frank Murch, 26. Admitted into hospital on August 14, 1904. On August 27, 1904, the 13th day of illness, 3·0 c.c. of blood were withdrawn from the right median-cephalic vein.

Result of Inoculations of Blood into Broth Tubes.

Amount of blood used.	Amount of medium broth used.	Result.
0·0025 c.c.	10 c.c.	Sterile.
0·005 ,,	,,	,,
0·0125 ,,	,,	,,
0·025 ,,	,,	,,
0·05 ,,	,,	,,

Result of Inoculations of Blood on to Petri's dishes.

Amount of blood used.	Amount of medium used.	Result.
0·1 c.c.	10 c.c.	Sterile.
,,	,,	,,
,,	,,	Contaminated.

On August 19, 1904, this man's blood had given 316 micrococci per cubic centimetre, *vide* Experiment XI.

Table showing the Average Number of *M. melitensis* per cubic centimetres of Blood and the Day of Disease.

Experiment.	Day of disease.	Number of micrococci per cubic centimetres of blood.
I	84	2·6
II	17	10
III	14	100
IV	25	1·0
V	23	0·0
VI	25	3·3
VII	40	2·0
VIII	20	0·6
IX	3	3·3
X	10	0·0
XI	5	316·6
XII	24	0·0
XIII	13	0·0

[*Remarks.*—It is evident from Staff-Surgeon Gilmour's experiments that the *M. melitensis* is present in the majority of the cases examined. Their number is, however, so small that it seems extremely doubtful if this disease can be carried by biting insects.—ED.]

INOCULATION EXPERIMENTS ON MONKEYS WITH MICRO-ORGANISMS, SUPPOSED TO BE *M. melitensis*, FROM THE BLOOD OF PATIENTS, SUFFERING FROM MEDITERRANEAN FEVER.

Experiment I.

A small, healthy, female Rangoon monkey, which had been under observation for 20 days. It had gone up in weight ½ lb., its coat had improved, and it appeared in perfect health. The temperature varied between 99°·6 and 101°·8. Its serum did not agglutinate *M. melitensis* in a dilution of 1—10. Weight 4 lbs. 12 ozs.

The object of this experiment was to prove that the coccus, obtained from the peripheral blood of a patient (W. A., age 32), was the *M. melitensis.*

October 6, 1903. This monkey was inoculated between the shoulder blades with an emulsion made from the contents of two sloped agar tubes (third generation of micrococcus) in 1 c.c. of broth.

October 7, 1903. Weight 4 lbs. 12 ozs.; appears well.

October 8, 1903. Weight 4 lbs. 10 ozs.; eating well.

October 9, 1903. Weight 4 lbs. 10 ozs.; seedy.

October 11, 1903. Weight 4 lbs. 5 ozs.; irritable, in other respects appears well. Its serum gives an immediate reaction to *M. melitensis* 1—10, 1—50, and 1—100 after 24 hours.

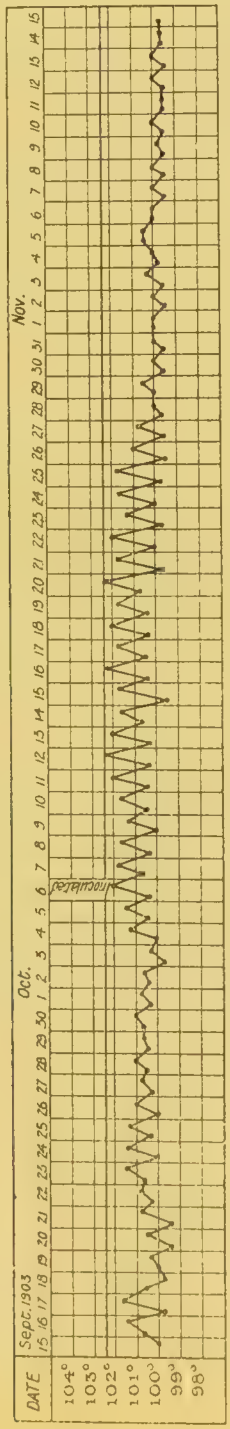
October 15, 1903. Weight 4 lbs. 2 ozs.; good reaction 1—100; seedy, but not very ill.

October 20, 1903. The monkey is improving in health. Slight reaction 1—50; good reaction, 1—30.

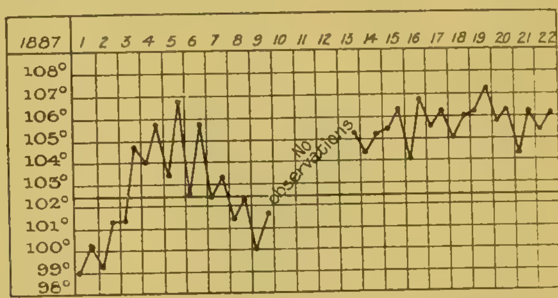
November 1, 1903. The animal has regained its weight and now weighs 4 lbs. 12 ozs. Perfectly well; reaction 1—10.

June 10, 1904. This monkey still reacts 1—10. It had no relapse.

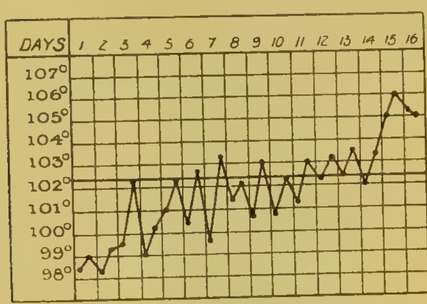
The following chart represents the temperature curve. Taken in the axilla.



[*Remarks.*—The temperature seems to have been taken in the axilla. It ought, in my opinion, to be taken in the rectum, the thermometer should be introduced as far into the intestine as possible, and a minimum of 5 minutes used for the observation. It is difficult to believe that this monkey can have had Malta Fever. The temperature chart shows no signs of the disease. Compare the following charts :—

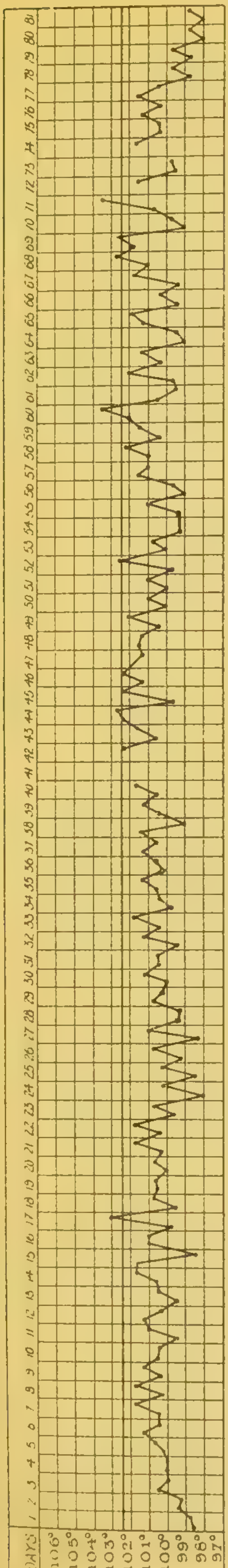


Monkey ♂. *Macacus rhesus.* Bruce. Temperature taken in the Axilla. Growth from Spleen.

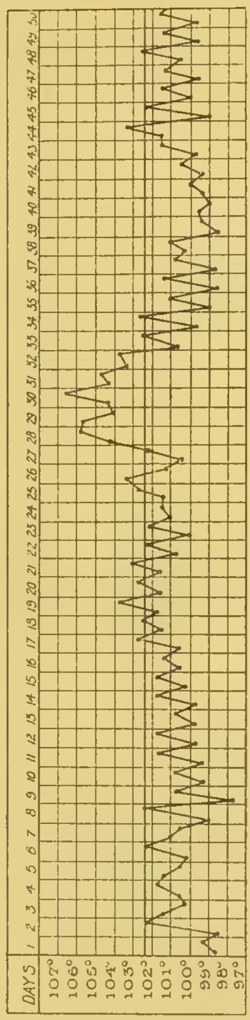


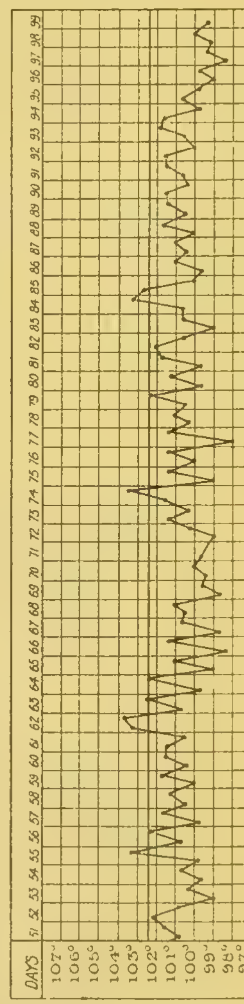
Monkey ♂. *M. rhesus.* Hughes. Axilla Temperature. Growth from Spleen.

Compare also the charts, Experiments V, VI, and XI Horrocks. In these cases the *M. melitensis* was recovered from the spleen after death. All these charts show a definite febrile disturbance, which is almost absent in the chart under consideration. It is certainly desirable that in these cases, the animal should be killed and the *M. melitensis* looked for in the spleen. Of course there is always the danger that the taking of the animal's temperature is entrusted to an ignorant or untrustworthy assistant.—Ed.]



Monkey ♂. Hughes. Axilla. Growth from Heart's Blood of Monkey.





Monkey ♀. *M. rhesus.* Hughes. Axilla. Growth from Spleen of Monkey.

Experiment II.

A small, healthy, male monkey, which had been kept under observation for 28 days. Weight 4 lbs. 9 ozs. No reaction 1—10.

November 16, 1903. This monkey was inoculated into the extensor muscles of the left thigh with 1 c.c. of an emulsion, made from three tubes of *M. melitensis* (first generation) in 2 c.c. of broth.

This experiment was carried out to prove that the growth, obtained from the peripheral blood of G. F., was the *M. melitensis.*

November 24, 1903. The monkey appears perfectly well. Weight 4 lbs. 8 ozs. Immediate agglutination reaction 1—400.

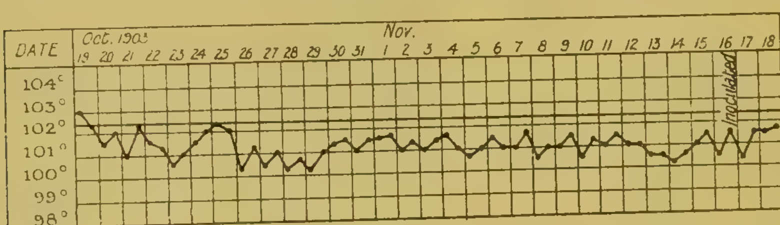
November 27, 1903. Weight 4 lbs. 8 ozs. Immediate agglutination reaction 1—400. The monkey was given a second injection of the contents of one tube, from same patient, into the muscles of the right thigh.

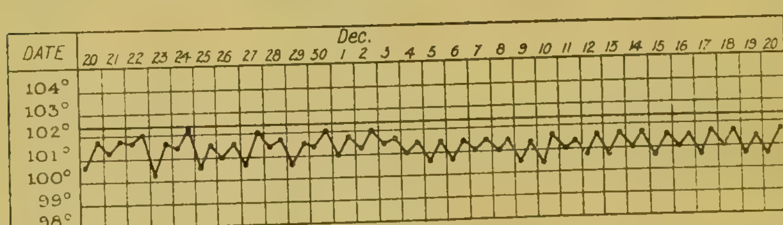
December 8, 1903. The monkey has remained perfectly well. Weight 4 lbs. 8 ozs. Agglutination reaction 1—200.

January 3, 1904. Monkey in good health. Agglutination reaction 1—200.

June 10, 1904. This monkey still reacts 1—10.

The following chart represents the temperature, taken in the axilla:





[*Remarks.*—This is also a very unsatisfactory temperature chart. The high agglutination reaction is, however, a strong argument that Staff-Surgeon Gilmour is dealing with *M. melitensis.*—Ed.]

Experiment III.

The following experiment was carried out to prove that the coccus, obtained from the knee-joint of F. B., age 21, was the *M. melitensis.*

December 5, 1903. A male monkey, which had been under observation for a week, was inoculated into the extensor muscles of the left

thigh with an emulsion made from one tube (fourth generation) in 1 c.c. of sterile broth. It weighed 7 lbs. 6 ozs.; its serum would not agglutinate the laboratory *M. melitensis;* and its temperature was steady, 100° F.—100°·6 F.

The monkey remained well until December 8, the 3rd day after inoculation, when it shivered a good deal, went off its feed, and suffered from a rise of temperature, 102° F., in the evening.

After this date the monkey became very sick; its serum gave a negative reaction 1—10 on December 8; reacted 1—1200 on December 13, 1—1200 on the 17, and 1—3000 on the 20, the 15th day after inoculation; its weight decreased 1 lb. 4 ozs. by December 22, and its temperature remained up after the 3rd day, ranging between 101° and 102°·8 F.

December 23, 1903. The monkey was killed with chloroform, and a *post-mortem* held.

The organs were healthy, with the exception of the liver and spleen, which were congested. There were no signs of tubercle. Two sloped agar and two broth tubes were inoculated from the liver, three agar and two broth from the spleen, two agar from the heart's blood, and 30 c.c. of broth with 1 c.c. of heart's blood.

December 29, 1903. The tubes from the liver remained sterile and were destroyed.

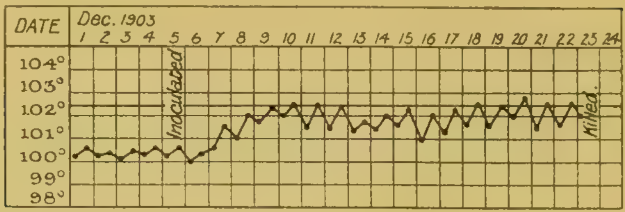
The agar tubes from the spleen showed no growth until the 3rd day, December 26, when many small isolated colonies appeared which, by the 4th day, had the appearance of a growth of *M. melitensis*. One broth tube from the same organ gave a growth by the 5th day; the other was sterile. A few transparent, isolated colonies also appeared on one agar tube from heart's blood on the 4th day.

The broth inoculated with heart's blood remained clear until the 3rd day, when it became slightly cloudy, after which the coccus grew rapidly; each field under the microscope being full of cocci. Sloped agar tubes (1 and 2), inoculated from the blood broth on December 24 and 27 respectively, remained sterile and were destroyed on December 29 and January 2. Two other tubes (3 and 4), inoculated on December 28, showed growth on December 31—isolated, transparent colonies, which the next day had every appearance of *M. melitensis*.

The tubes from the blood and spleen were examined microscopically, etc., and the growth—a micrococcus—was found to be identical in size, shape, motility, and staining reactions with the laboratory *M. melitensis;* it also gave an immediate agglutination reaction with the sera of the following Mediterranean fever patients: A. 1—500, B. 1—1000, P. 1—100, but not with healthy serum.

I think that the above experiments prove conclusively that the coccus, obtained in the first place from the synovial fluid of the knee-joint, was the *M. melitensis*.

The following chart shows the temperature curve :



[*Remarks.*—There can be little doubt that in this case Staff-Surgeon Gilmour is dealing with the *M. melitensis.* There is a distinct rise of temperature and the micro-organism was recovered from the spleen and blood.—Ed.]

6.

ISOLATION OF THE *MICROCOCCUS MELITENSIS* FROM THE BLOOD.

By Dr. T. Zammit, Member Mediterranean Fever Commission.

The patients of the Civil Central Hospital furnished, for the most part, the material for this investigation. The Honourable the Comptroller of the Charitable Institutions and the Medical Officers connected with that hospital deserve the thanks of the Commission for having kindly allowed the investigation to be conducted in the hospital.

The method followed at first was the simple one of drawing blood with a syringe from a vein at the bend of the arm. One to five cubic centimetres of blood was drawn, with all necessary precautions, and diluted in broth in the proportion of 1 of blood to 19 of broth. A proportion of 1 to 9 of broth was tried, but found unsuitable.

As soon as the blood was mixed with the broth it was taken to the laboratory where it was put in various proportions in 10 c.c. broth tubes and incubated. From the first mixture of blood 1, 2, 3, 4, 5 c.c., etc., were added to broth tubes and the dilution noted.

After an incubation of 4—5 days, a loopful of broth was passed over a sloped agar tube. When after 5 days no growth appeared on the agar, the same tube was reinoculated from the corresponding tube of broth, and so on every 5 days up to 1 month.

If a growth appeared having the appearance of the *M. melitensis* a note was made and the tube set aside for identification; if numerous

foreign growths appeared, the tube was usually thrown away and a note made that it was contaminated.

In some cases, however, the *M. melitensis* could be easily recognised among a lot of contaminations, and then sub-cultures were made to get a pure culture of the Micrococcus.

The contaminations observed during this investigation were traced to the imperfect preparation of the skin before drawing the blood, and, in fact, the contaminations were reduced to a minimum when a pad with carbolic solution (5 per cent.) was kept on the part for a few hours previous to the operation.

No bad effects were ever observed after the puncture, and no complaints were ever made by the patients.

After some time a few cases were met with in which, owing either to the prostrate condition of the patient or to his excessive nervousness the drawing of the blood from a vein by means of a syringe was not found to be possible. I, therefore, devised the following method of taking the blood which has proved so successful that I resorted to it constantly afterwards:—

The finger or the lobe of the ear of the patient is washed well with ether, ether-soap, water, alcohol and ether, and on the dry skin a puncture is made with a small syringe needle. With a sterile cotton wool pad the first drop of blood is removed, and an assistant squeezes the part for the next drop at the request of the operator. In a test-tube a large number of capillary tubes 1 cm. long are sterilised by dry heat, and at the time of collecting the blood, one of these short tubes is taken with fine forceps passed, immediately before, through the flame. As soon as the assistant squeezes the part and removes the cotton-wool pad, the tube is brought in contact with the drop, and when full is immediately put in a broth tube. This operation is repeated as long as the blood continues to ooze; six tubes are usually filled. From these broth tubes, marked and incubated, passages on agar are made in the usual manner.

When a growth of *M. melitensis* is obtained on the agar slope, the capillary tube is drawn out of the broth, washed, dried, and weighed. It is then weighed again full of distilled water, and the difference between the two weights gives the volume of liquid the tube can hold, thus establishing to a nicety the amount of blood from which the *M. melitensis* has been isolated. By this method a volume of 0·005 of 1 c.c. of blood has been easily and accurately measured.

This method was used in twenty-two cases out of fifty with good results. Greater care is, of course, required in the disinfection of the skin, but when this extra trouble is taken the results compare most favourably with the bleeding from a vein. This method has also the great advantage that it can be applied to animals, as in case No. 50 in Table A.

Table A.

Order number.	Name and surname.	Sex.	Age.	Date of illness.	Character of case.	Temperature of body at time of experiment.	Amount of blood taken.	Minimum amount of blood in which *M. melitensis* was found.	Date of observation.	Remarks.
				Day.		°	c.c.	c.c.	1904.	
1	Giorgio Abdilla	M	40	25	Mild	99·8	2	—	June 21	No growth whatever.
2	Paolo Spiteri	M	49	100	,,	99·0	1	—	,,	,, ,,
3	Emmanuele Caruana	M	24	65	,,	99·8	1	0·1	June 23	
4	Ursola Vassallo	F	56	20	,,	101·0	1	0·1	,,	
5	Salvatore Camilleri	M	28	120	,,	100·0	1	—	June 27	,, ,,
6	Maria Chelcuti	F	29	13	Acute	100·2	1	0·2	,,	
7	Carmela Dimech	F	18	35	Mild	101·0	1	0·1	July 7	
8	Giuseppe Cordina	M	31	240	,,	99·8	1	—	,,	,, ,,
9	Alfredo Scicluna	M	38	14	Acute	102·0	1	0·1	July 8	
10	Pasquale Cachia	M	33	8	Mild	99·0	1	—	,,	,, ,,
11	Francesco Saliba	M	45	15	Acute	100·0	1	0·1	July 11	
12	Salvatore Ungaro	M	25	30	Mild	99·1	1	—	,,	,, ,,
13	Antonia Hili	F	23	8	Acute	104·4	few drops	0·02	July 15	
14	Luigia Brina	F	45	13	,,	103·2	,,	0·02	,,	
15	Carmelo Camilleri	M	21	30	Mild	103·2	1	—	,,	Tubes contaminated.
16	Giuseppe Farrugia	M	36	14	,,	101·0	1	—	,,	No growth whatever.
17	Mosè Azopardi	M	29	10	Acute	103·4	1	0·1	July 18	
18	Luigia Brina	F	45	16	,,	102·0	1	0·1	,,	
19	Raffaele Mercieca	M	15	7	,,	105·4	1	0·1	July 22	
20	Carmelo Fava	M	24	13	Mild	102·4	1	—	,,	Tubes contaminated.
21	Simeone Cumbo	M	30	15	,,	101·4	1	0·2	,,	
22	Giuseppe Micallef	M	39	18	,,	102·4	1	0·1	,,	
23	Caterina Pons	F	44	54	,,	102·0	1	0·1	July 27	

24	Angelo Inguanez...........	M	37	12	Acute	102·0	1	0·5	"	
25	Nattar Bassar..............	M	22	7	"	101·0	1	0·1	"	
26	Marianne Grima............	F	24	32	Mild	101·0	1	0·1	"	
27	Vincenzo Mamo.............	M	27	22	"	101·0	few drops	—	"	" "
28	Salvatore Bonanno..........	M	46	13	"	101·0	"	—	"	" "
29	Carmelo Vella..............	M	26	150	"	99·0	"	—	"	" "
30	Patrick Bourke.............	M	33	65	"	99·4	"	—	"	" "
31	Giovanni Buhagiar..........	M	29	6	Acute	102·0	"	—	Aug. 4	" "
32	Carmelo Micallef...........	M	15	33	Mild	99·0	"	—	"	" "
33	Giuseppe Zammit...........	F	17	7	Acute	104·0	"	0·0097	Aug. 9	
34	Gio. Maria Mifsud..........	M	55	10	"	101·0	1	0·1	Aug. 10	
35	Carmela Zammit............	F	17	8	"	103·8	1	0·025	"	
36	Maria Teresa Perini........	F	22	21	Mild	102·0	few drops	—	Aug. 11	No growth whatever.
37	Maria Anna Fenech..........	F	25	30	"	102·0	"	—	"	" "
38	Nicola Farrugia............	M	48	18	"	100·6	1	—	Aug. 12	" "
39	Tancredi Piacentini........	M	31	7	Acute	102·2	1	0·025	"	
40	Carmelo Grech..............	M	43	35	Mild	102·4	1	0·05	"	
41	S. Valder..................	F	25	7	Acute	104·0	few drops	0·005	Aug. 17	
42	Carmela Bugeja.............	F	27	17	"	105·0	"	0·009	"	
43	Giuseppa Grima.............	F	43	60	"	106·0	"	0·008	"	
44	Anna Zammit................	F	40	120	Mild	103·0	"	—	Aug. 22	" "
45	Jos. Sullivan..............	M	6	14	Acute	102·4	"	—	Aug. 24	Tubes contaminated.
46	Carmelo Delicata...........	M	56	18	Mild	99·0	"	—	Aug. 25	" "
47	Vincenzo Abela.............	M	32	8	"	101·0	"	—	"	No growth whatever.
48	Gaetano Billion............	M	21	6	Acute	103·0	"	0·006	"	
49	Nicola Farrugia............	M	48	31	Mild	103·0	"	—	"	" "
50	Monkey No. 63..............	M	—	16	Acute	105·0	"	0·005	Aug. 27	

The examination of fifty cases, made between June 21 and August 27, show that the *M. melitensis* circulates freely in the blood during an attack of fever, and that the amount of Micrococci varies usually with the temperature of the body.

In the fifty cases tabulated the *M. melitensis* was never recovered when the body temperature was below 100° F. At 102° and over it was recovered with the exception of two cases (Nos. 36 and 37), in which the tubes remained sterile, and in four cases in which the tubes were hopelessly contaminated. From one of these cases (No. 15) the *M. melitensis* was isolated by one of my colleagues on the same day.

Attempt to infect a monkey by means of a mosquito which had previously fed on a Mediterranean Fever patient.

Several mosquitoes (*Stegomyia fasciata*), which had previously been fed on an infected monkey (No. 45), were made to bite two healthy monkeys. No positive results were obtained. A positive result was obtained on the third attempt.

The third monkey (No. 63) was bought in Malta, along with two others, from a ship coming from the East Indies. Its temperature was taken twice daily after July 18, and it kept always within normal limits up to August 15.

The monkey was kept on the terrace on a side facing south-east, along with seven other animals, none of which had ever been ill.

On July 27 the blood of this monkey was tested, and it did not react to *M. melitensis* when diluted to 1 in 10.

On August 10 at 11 A.M. the monkey was bitten by two *Stegomyias* which had been fed at 11 A.M. on August 8 on a patient affected with a sharp relapse of Mediterranean Fever at the Civil Hospital (patient P. Sillato, Bed No. 40).

On August 20 the monkey was bitten again by one of the two *Stegomyias* used on the 10th.

On August 23 (13 days after inoculation) a rise of temperature was observed, and the blood of the animal was tested for Mediterranean Fever reaction, but no clear reaction could be obtained.

On August 26 the temperature rose again, and on the blood being tested, it was observed that it reacted strongly to *M. melitensis*. An immediate and complete agglutination was obtained at various dilutions up to 1 in 300. No further dilutions were tried.

The animal had obviously a sharp attack of fever, but the isolation of the coccus from the blood was necessary to make sure of the disease.

Without killing the animal, on August 31 one of its ears was properly disinfected and blood was drawn by pricking a small vein. The

blood was collected in small capillary pipettes 1 cm. long, in the manner described in another part of the Report, and put in broth.

On September 1 passages on agar were made from the broth tubes, and on the 4th a distinct growth was observed in one of the tubes. On the 5th two other tubes were found to have grown the Coccus.

All the growths tested in the ordinary way showed that the microbe was the *M. melitensis* in pure culture.

The least amount of blood from which the *M. melitensis* was obtained in this case was 0·005 c.c. Smaller quantities were not tried.

The position of the other monkeys, both healthy and ill, at the time of the experiment, is shown in the plan (p. 42). It is easily seen that no infected monkeys were anywhere near No. 63, and, therefore, direct infection from the monkeys, then ill on the same terrace, is highly improbable.

Experiments made in Malta by Dr. Zammit before the Appointment of the Commission.

1. *To Test Vitality of* M. melitensis *on Filter-paper exposed to Diffused Light.*

August	27,	1903.	A strip of filter-paper was hung on a wire inside a test-tube plugged with cotton-wool and sterilised by dry heat.
,,	28,	,,	Strip of filter-paper smeared with loopful of agar culture. Twelve tubes prepared in the same manner.
September	1,	,,	The filter-paper dropped in a broth tube and incubated. Growth obtained in due time.
,,	2,	,,	,, ,, Same result.
,,	3,	,,	,, ,, ,,
,,	4,	,,	,, ,, No growth obtained.
,,	5,	,,	,, ,, ,, ,,
,,	6,	,,	,, ,, ,, ,,

Conclusion.—*M. melitensis* retained its vitality for 7 days in diffused light. This experiment was repeated three times with the same result.

2. *To Test Vitality of* M. melitensis *in various Coloured Lights.*

Agar tubes inoculated with a drop of broth culture were incubated in cardboard boxes, of which the cover was made of a coloured glass plate. Violet, red, green, yellow, and blue plates were used. One tube was left in diffused light, and another one was wrapped in black paper.

Result.—No difference in growth was observed in the different tubes. The experiment was repeated three times with the same result, the tube exposed to blue light showing once a richer growth than the rest.

3. *Action of Direct Sunlight on Growth of* M. melitensis *in Agar Tubes.*

September 17, 1903. Agar tube inoculated with 1 drop of broth culture was exposed for 15 minutes to the direct action of sunlight at about noon. Control tubes left in diffused light. No growth appeared before the 3rd day, but on the 4th day a growth was seen which in a few days was much more luxuriant than that on control tubes.

The experiment was repeated twice with the same result.

4. *Vitality of* M. melitensis *on Ordinary Limestone.*

September 12, 1903. Small bits of ordinary white porous limestone were taken and thoroughly sterilised. Emulsion made of *M. melitensis* from agar in sterile distilled water and the bits of stone wetted with this. The whole was kept in a dry atmosphere. On the 3rd day bits of the stone were dropped in broth tubes.

As former experiments had shown that light favours the growth of the *M. melitensis*, part of the bits of stone wetted with *M. melitensis* emulsion was kept in diffused light and part in a tube wrapped in thick black paper. The other conditions of the two tubes with pieces of stone were the same.

The result of the experiment was as follows:—

	Stone kept in dark.	Stone kept in diffused light.
Sept. 15 (3rd day).	Growth of *M. melitensis.*	Growth of *M. melitensis.*
„ 18 (6th „).	„ „	„ „
„ 19 (7th „).	„ „	„ „
„ 20 (8th „).	„ „	„ „
„ 26 (14th „).	No growth.	„ „
Oct. 28 (46th „).	„	„ „
Nov. 2 (51st „).	„	„ „
„ 19 (68th „).	„	No growth.

Conclusion.—Vitality of *M. melitensis* on limestone, in the dark, from 8 to 14 days.

Vitality of *M. melitensis* on limestone, in diffused light, not less than 51 days.

The experiment was repeated three times with practically the same result.

5. *To Test the Action of* M. melitensis *on the Reaction of Media.*

September 22, 1903.		Seventy cubic centimetres of peptone broth with a reaction of +6, Eyre's scale, inoculated with loopful of *M. melitensis* from agar, and incubated at 37° C.
„	26, „	Acidity reduced to +2.
October	28, „	Broth distinctly alkaline.

6. October 29, 1903. A series of test-tubes with 20 c.c. of broth in each were inoculated with a loopful of agar culture of *M. melitensis.* The tubes were then placed in large Buchner tubes half full with water and lightly covered so as to reduce the evaporation to a minimum. The whole was then incubated at 37° C. Tubes with broth were put for control in the same conditions.

November 19, „	(20th day).	Acidity of broth	+ 2.
January 21, 1904	(82nd „).	Broth alkaline	− 3.
February 18, „	(110th „).	„	− 4·5.

The control tubes showed an increased acidity. On the 20th day the acidity in the control tubes had doubled.

(This experiment is being repeated.)

7.

INTERIM REPORT OF EXPERIMENTAL WORK IN THE INVESTIGATION OF MEDITERRANEAN FEVER DEALING WITH BLOOD, SKIN, SWEAT, FILTRATIONS, AGGLUTINATING SERUM AND VARIOUS INOCULATIONS ON DIFFERENT ANIMALS.

By Staff-Surgeon E. A. Shaw, R.N., Member Mediterranean Fever Commission.

Examination of Blood.

The peripheral blood of Malta Fever patients has been examined by me for the *Micrococcus melitensis* (hereafter referred to as *M. melitensis*) in fifty-one cases, the results of which I append in a tabular form.

Method.—Bend of elbow prepared as for a surgical operation, blood withdrawn from median-basilic vein direct by means of carefully sterilised serum syringe.

½ c.c.	distributed over surface of agar		in a Petri dish		A.
1 „	„		„	„	B.
2 „	„		„	„	C.
1 „	put into a 19 c.c. peptone broth tube			„	D.
1 „	„	another 19 c.c.	„	„	E.

ABCD kept intact, E used for making dilutions immediately, first well mixing blood and broth through a series of broth tubes by means of graduated pipettes sterilised in boiling water. At first the dilutions proceeded by multiples of 10; for instance, tube D contained 1 c.c. blood and 19 c.c. broth = a dilution of $\frac{1}{20}$, $2\frac{1}{2}$ c.c. of this contained $\frac{1}{8}$ c.c. blood and added to a 10 c.c. broth tube = $\frac{1}{8}$ c.c. of blood in $12\frac{1}{2}$ of mixture = a dilution of $\frac{1}{100}$; and abstracting 1 c.c. of this ($\frac{1}{100}$ c.c. of blood) and adding to a 9 c.c. broth tube = $\frac{1}{100}$ c.c. of blood in 10 of mixture = $\frac{1}{1000}$ dilution and so on up to $\frac{1}{100000}$.

All broth tubes and plates were duly labelled with a serial number for each patient, the quantity of blood contained, and the date and placed in the incubator at 37° C.

As time went on and the series of bloods increased it was found that *M. melitensis* was only being recovered from relatively large quantities of blood, up to Blood 15 never even from $\frac{1}{100}$ c.c. of blood and only occasionally from $\frac{1}{9}$ c.c., intermediate dilutions containing $\frac{1}{2}$ c.c., $\frac{1}{4}$ c.c., and $\frac{1}{16}$ c.c. of blood were, therefore, made and incubated for Bloods 16, 17, 18, 19. The primary dilutions in Bloods 20 to 25 were made by multiples of 3 from the $\frac{1}{20}$ dilution, *i.e.*, $\frac{1}{60}$, $\frac{1}{180}$, $\frac{1}{540}$, $\frac{1}{1620}$, and $\frac{1}{4860}$. From Blood 26 onwards to Blood 51 by multiples of 2; thus one tube containing 19 c.c. of broth and one of blood remained as the unit 1 c.c. of blood, the other tube of similar contents had 10 c.c. abstracted and was hence left containing $\frac{1}{2}$ c.c. blood, the 10 c.c. removed was added to a 10 c.c. broth tube, the resulting 20 c.c. of mixture well amalgamated, and 10 c.c. then abstracted thus leaving it containing $\frac{1}{4}$ c.c. blood; and thus tubes containing $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{128}$, and $\frac{1}{256}$ c.c. respectively of blood were prepared, the intention being to increase these dilutions if *M. melitensis* was ever recovered from the highest, though the first twenty-five bloods drawn had not yielded it in so high a dilution as $\frac{1}{100}$.

These blood dilutions were daily thoroughly well shaken to give the *M. melitensis* an opportunity of emerging from the leucocyte in which it was thought to be most probably lodged, and after 5 days incubation, subcultures on to agar slopes from the respective broth tubes were prepared and incubated at 37° C. These inoculations of agar slopes were repeated when considered necessary and no blood dilution was abandoned as unfruitful till it had been incubating at least 11 days.

The Petri dish method was worked side by side with the broth enrichment method for the first seventeen cases, afterwards it was abandoned. The original idea was that the number of colonies of *M. melitensis* appearing could be taken as an index of the quantity of *M. melitensis* in the measured quantity of blood taken. It was found quite easy by inclining the plate to get the blood put on the agar surface to spread itself quite evenly over the whole area of agar forming a very thin layer, but when, as in Cases 10, 12, 14, and 16,

M. melitensis was recovered by the broth method, while the plate method failed to show it, time was felt to be too valuable to persevere with the latter.

Of the details given in the tabulated results some explanation is necessary. In the column headed nation and sex, E = English, M = Maltese, A = Army, N = Navy, F = Female, and as the only female patients from which blood was taken were Maltese, the sex is specified only for that nationality, thus M.M. = Maltese male, and M.F. = Maltese female. The English patients were all male.

The temperatures given preceding drawing of blood are for the few days immediately prior to drawing of blood, the last being the temperature on day of abstraction of blood, these are given as follows: $\frac{101}{103}$ the upper temperature being the morning the lower the evening temperature. In some of the Maltese cases where, owing to the frequent unexpected discharge of patients at their own request prompt action was necessary, blood was taken very soon after admission, and in such cases temperature for only 1 or 2 days could be so given.

The day of disease is enumerated from the first onset of symptoms attributable to the fever.

The time at which blood was drawn is given, it was noted with the intention of seeing if any difference in result would appear between blood taken in the forenoon and that taken in the evening, the patient's temperature at time of drawing is here given also.

The agglutination test was applied by me to all samples of blood drawn, to independently confirm the diagnosis of Malta Fever, and after working out eighteen bloods, it was felt it would be of interest to know the *limit dilution* which would agglutinate a standard fresh agar growth of *M. melitensis* to see if there was any relation between amount of *M. melitensis* obtained from a given blood and the agglutinating power of the latter. The standard taken is an arbitrary one, being that agglutination should be unmistakably marked under the $\frac{2}{3}$ inch objective, 15 minutes after the mixing of *M. melitensis* emulsion and diluted serum, invariably comparison was made with a control.

In the column headed Recovery of *M. melitensis* the sign + means recovery, and the sign − means no recovery.

Smallest quantity of blood means the smallest quantity calculated from the highest broth dilution yielding *M. melitensis* and the amount of blood therein contained.

The following tests were invariably applied to each recovery of *M. melitensis*. before it was entered as such in the laboratory records:—

1. Growth on agar slope should be that characteristic of *M. melitensis.*

2. Size and appearance of cocci in film stained with dilute carbol-fuchsine should be characteristic.

No. of case.	Nation and sex.	Age.	Stage of the fever.	Temperature of patient for few days preceding bleeding.	Day of disease.	Time of bleeding and patient's temperature.	Maximum dilution of patient's blood swing aggl.	Recovery of *M. melitensis*.	Smallest quantity of blood giving *M. melitensis*.
				° F.					
1	E. A.	37	Had 3 waves. Now convalescent	Normal for preceding 20 days	98th	12.30 noon, N.	Aggl.	+	$\frac{1}{2}$ c.c.
2	,,	31	Had 1 wave	Normal for preceding 7 days	30th	12.30 noon, N.	Aggl.	–	
3	,,	28	T. never normal since admitted; a long severe case	E.T.'s = 101, 100, 99, 99.	101st	12.30 noon, N.	Aggl.	–	
4	,,	31	Mild case, 4 waves ..	Normal for preceding 30 days.	108th	12.30 noon, N.	Aggl.	–	
5	M. M.	40	End of 4th wave ..	$\frac{99}{99}$, $\frac{98}{98 \cdot 4}$, $\frac{99}{-}$	74th	Noon, N.	Aggl.	–	
6	,,	22	In 1st wave	$\frac{101 \cdot 6}{102 \cdot 4}$, $\frac{101}{102 \cdot 6}$, $\frac{101}{-}$	15th	Noon, 100°·8	Aggl.	–	
7	,,	24	End of 2nd wave..	$\frac{99 \cdot 4}{101}$, $\frac{99}{99}$, $\frac{98}{99}$, $\frac{98}{}$	49th	11.30 noon, N.	Aggl.	+	$\frac{9}{10}$ c.c.
8	M. F.	56	End of 2nd wave..	$\frac{N.}{100}$, $\frac{N.}{99 \cdot 6}$, $\frac{N.}{99}$, $\frac{N.}{-}$	30th	11.30 A.M., N.	Aggl.	+	$\frac{9}{10}$ c.c.
9	,,	28	Nearing end of 2nd wave	$\frac{99}{102}$, $\frac{99}{101 \cdot 6}$, $\frac{99 \cdot 6}{101 \cdot 2}$, $\frac{100 \cdot 4}{-}$	41st	Noon, 100°	Aggl.	–	
10	,,	18	No information ...	$\frac{N.}{101}$, $\frac{99}{101}$, $\frac{98}{101 \cdot 6}$, $\frac{101}{-}$	37th	11.45 A.M., 100°·6	Aggl.	+	$\frac{7}{8}$ c.c.
11	M. M.	31	Now in hospital for orchitis. Had fever 8 months ago	Normal for months..	240th	Noon, N.	Aggl. $\frac{1}{40}$	–	

12	,,	38	In 1st wave	$\frac{100}{100}, \frac{99 \cdot 6}{101}, \frac{99}{100}, \frac{100}{102}$	10th	5.15 P.M., 102°	Aggl.	+	$\frac{1}{2}$ c.c.
13	,,	30	In 1st wave	$\frac{-}{102 \cdot 5}, \frac{98}{99}$	9th	5.30 P.M., 99°	Aggl.	–	
14	,,	47	Ill at home 3 months. Now admitted because worse	$\frac{100}{102}, \frac{101}{101}, \frac{100}{101}, \frac{100}{99 \cdot 4}$	95th	5.0 P.M., 99°·4	Aggl.	+	$\frac{1}{2}$ c.c.
15	,,	25	Nearing end of 1st wave	$\frac{101}{101}, \frac{101}{99 \cdot 2}, \frac{99 \cdot 2}{99 \cdot 2}, \frac{99 \cdot 1}{-}$	31st	5.20 P.M., N.	Aggl.	–	
16	,,	22	Middle of 3rd wave	$\frac{99}{103 \cdot 2}, \frac{99}{103 \cdot 2}, \frac{100 \cdot 4}{103 \cdot 2}, \frac{102}{102}, \frac{103 \cdot 6}{103 \cdot 2}$ ..	38th	5.10 P.M., 103°·2	$\frac{1}{1000}$	+	$\frac{1}{4}$ c.c.
17	,,	36	In 1st wave	$\frac{-}{100 \cdot 2}, \frac{101 \cdot 3}{101}, \frac{101}{103}, \frac{101 \cdot 1}{101}, \frac{101}{101 \cdot 6}$ ..	17th	5.25 P.M., 101°·6	Aggl. $\frac{1}{40}$	–	
18	,,	29	In 1st wave	$\frac{-}{102 \cdot 8}, \frac{102 \cdot 2}{103 \cdot 4}$	9th	5.30 P.M., 103°·4	$\frac{1}{40}$	+	$\frac{1}{2}$ c.c.
19	M. F.	44	In 1st wave	$\frac{102 \cdot 4}{103 \cdot 8}, \frac{103}{102 \cdot 4}, \frac{101}{103}, \frac{101 \cdot 2}{103}, \frac{101}{102}$ ..	15th	5.45 P.M., 100°·5	$\frac{1}{640}$	+	$\frac{1}{8}$ c.c.
20	E. N.	22	In 2nd wave.... .	$\frac{100}{103 \cdot 6}, \frac{100}{102 \cdot 6}, \frac{100}{102 \cdot 4}, \frac{99 \cdot 6}{102 \cdot 4}, \frac{100 \cdot 2}{-}$	22nd	10.30 A.M., 100°	$\frac{1}{500}$	–	
21	,,	32	In 1st wave	$\frac{101}{102 \cdot 4}, \frac{102 \cdot 2}{103}, \frac{97 \cdot 6}{99 \cdot 6}, \frac{N.}{100}, \frac{N.}{-}$	28th	10.20 A.M., N.	$\frac{1}{1000}$	–	
22	M. M.	15	In 1-t wave	$\frac{103 \cdot 6}{104 \cdot 2}, \frac{102}{105 \cdot 4}$	11th	5.30 P.M., 103°·8	$\frac{1}{300}$	+	$\frac{3}{4}$ c.c.
23	,,	24	In 1st wave. Continuous fever	$\frac{101}{102 \cdot 4}, \frac{101}{102 \cdot 4}$	31st	5.40 P.M., 102°	$\frac{1}{300}$	+	$\frac{1}{6}$ c.c.
24	,,	29	In 1st wave	$\frac{103}{103}, \frac{102}{102 \cdot 6}, \frac{101 \cdot 4}{102 \cdot 4}, \frac{101 \cdot 6}{101}, \frac{99 \cdot 8}{101 \cdot 4}$ ..	13th	5.50 P.M., 99°·4	$\frac{1}{1080}$	–	
25	M. F.	39	In 1st wave	$\frac{99 \cdot 4}{101}, \frac{99 \cdot 4}{101 \cdot 6}, \frac{100}{101 \cdot 4}, \frac{100}{101 \cdot 4}, \frac{100}{102 \cdot 4}$	18th	6.10 P.M., 101°·4	$\frac{1}{1080}$	–	
26	M. M.	37	In 1st wave	$\frac{100}{102 \cdot 4}, \frac{100 \cdot 8}{102}, \frac{98}{101}, \frac{101}{102}$	12th	5.0 P.M., 102°	$\frac{1}{1000}$	+	1 c.c.
27	,,	22	In 1st wave	$\frac{-}{100}, \frac{100}{101}$	7th	5.15. P.M., 102°	$\frac{1}{800}$	+	$\frac{1}{8}$ c.c.

No. of case.	Nation and sex.	Age.	Stage of the fever.	Temperature of patient for few days preceding bleeding. (° F.)	Day of disease.	Time of bleeding and patient's temperature.	Maximum dilution of patient's blood swing aggl.	Recovery of *M. melitensis.*	Smallest quantity of blood giving *M. melitensis.*
28	M. F.	24	In 1st wave. Continuous fever	$\frac{99{\cdot}6}{102{\cdot}8}$, $\frac{101{\cdot}2}{103}$, $\frac{101}{101{\cdot}2}$, $\frac{99}{101{\cdot}8}$, $\frac{100}{103{\cdot}2}$	32nd	5.30 P.M., 102°	$\frac{1}{1200}$	−	
29	,,	44	In 2nd wave......	$\frac{101}{102{\cdot}4}$, $\frac{99}{102{\cdot}6}$, $\frac{100{\cdot}2}{102}$, $\frac{100{\cdot}2}{101{\cdot}6}$, $\frac{101{\cdot}4}{102}$	56th	5.45 P.M., 101°·8	$\frac{1}{1000}$	+	$\frac{1}{4}$ c.c.
30	E. A.	23	In 1st wave	$\frac{101}{102{\cdot}3}$, $\frac{100{\cdot}6}{102{\cdot}8}$, $\frac{100{\cdot}6}{102{\cdot}8}$, $\frac{100{\cdot}5}{101{\cdot}8}$, $\frac{100{\cdot}4}{}$	15th	11.0 A.M., 100°	$\frac{1}{500}$	+	$\frac{1}{16}$ c.c.
31	,,	27	In 1st wave	$\frac{100}{101}$, $\frac{101{\cdot}6}{103}$, $\frac{101{\cdot}6}{103}$, $\frac{101{\cdot}6}{104{\cdot}2}$, $\frac{102}{\ldots}$	22nd	11.15 A.M., 101°·8	$\frac{1}{800}$	−	
32	,,	37	In 1st wave	$\frac{99}{101{\cdot}6}$, $\frac{99{\cdot}6}{103{\cdot}4}$, $\frac{101}{102{\cdot}6}$, $\frac{102}{103}$, $\frac{99{\cdot}4}{\ldots}$	36th	11.30 A.M., 99°·8	$\frac{1}{2000}$	+	1 c.c.
33	M. M.	55	In 1st wave	$\frac{100}{100}$, $\frac{99{\cdot}4}{100{\cdot}6}$, $\frac{99{\cdot}2}{100{\cdot}6}$, $\frac{99{\cdot}4}{102{\cdot}2}$, $\frac{101}{101}$	10th	5.10 P.M., 101°	$\frac{1}{600}$	+	1 c.c.
34	,,	17	In 1st wave	.... $\frac{103}{104}$	8th	5.30 P.M., 103°·8	$\frac{1}{400}$	+	$\frac{1}{64}$ c.c.
35	,,	38	In 1st wave	$\frac{101}{101}$, $\frac{101}{101}$, $\frac{99{\cdot}2}{101}$, $\frac{N.}{102}$, $\frac{99{\cdot}2}{100{\cdot}6}$	18th	5.0 P.M., 100°·6	$\frac{1}{800}$	+	$\frac{1}{2}$ c.c.
36	,,	31	In 1st wave	.... $\frac{101}{103{\cdot}8}$, $\frac{101{\cdot}8}{102{\cdot}2}$	7th	5.10 P.M., 102°·2	$\frac{1}{40}$	+	$\frac{1}{128}$ c.c.
37	,,	43	No information ...	.... $\frac{101{\cdot}8}{102{\cdot}4}$	36th	5.20 P.M., 102°·4	$\frac{1}{1000}$	+	$\frac{1}{64}$ c.c.
38	E. A.	22	Middle of 2nd wave	$\frac{102{\cdot}6}{103}$, $\frac{102{\cdot}8}{104}$, $\frac{101}{103{\cdot}8}$, $\frac{102}{103{\cdot}4}$, $\frac{102{\cdot}6}{102}$	26th	5.40 P.M., 102°	$\frac{1}{1000}$	+	$\frac{1}{16}$ c.c.

39	,,	21	Near end of 1st wave	104/104·2, 103/104, 101/102, 98·4/99·8, 98·4/—	9th	11.0 A.M., 98°·4	$\frac{1}{800}$	+	$\frac{1}{8}$ c.c.
40	,,	22	Near end of 3rd wave	98·6/100·6, 99·2/100·6, 99·2/101, 99·6/100·6, 99·2/— ..	57th	11.10 A.M., 99°·2	$\frac{1}{1000}$	–	
41	,,	38	Near end of 2nd wave	98·8/100·8, 98·6/100, 98·4/100·2, 99/100·2, 99/—	48th	11.20 A.M., 99°·4	$\frac{1}{1800}$	–	
42	,,	32	Near end of 2nd wave	100·4/102·3, 100·4/102·7, 100·1/101·5, 99·5/102, 99·4/— ..	55th	11.30 A.M., 99°·6	$\frac{1}{600}$	+	$\frac{1}{64}$ c.c.
43	E. N.	26	In 1st wave	98/99·4, 99/99·4, 98·6/99·6, 99·6/100·6, 99·8/—	15th	10.30 A.M., 99°·6	$\frac{1}{800}$	+	$\frac{1}{250}$ c.c.
44	,,	27	In 1st wave	99·2/100·4, 99/102, 97·6/101·4, 98·6/101, 98·6/—	17th	10.20 A.M., N.	$\frac{1}{1500}$	–	
45	E. A.	31	Nearing end of 2nd wave	98·6/100, 98·4/100·6, 98·5/100·2, 98·4/101, 98·8/— ...	41st	9.50 A.M., 99°	$\frac{1}{600}$	+	$\frac{1}{16}$ c.c.
46	,,	27	Nearing end of 3rd wave	100/101, 100/102·6, 100/101, 99·2/101, 99/—	69th	10.5 A.M., 99°	$\frac{1}{1400}$	–	
47	,,	20	Middle of 1st wave	102·2/103·4, 102/103·4, 101·2/103·2, 101/103, 101/—	25th	11.10 A.M., 101°	$\frac{1}{1000}$	+	$\frac{1}{250}$ c.c.
48	,,	20	Now commencing 2nd wave	99/101·6, 101/103·5, 101/103·4, 102·4/103·2, 101/— ..	28th	11.20 A.M., 101°	$\frac{1}{1800}$	–	
49	,,	38	Height of 1st wave	100/103·6, 102/104·6, 102·8/104·7, 101/105·6, 102/— ..	22nd	11.30 A.M., 102°	$\frac{1}{1400}$	+	1 c.c.
50	,,	20	Middle of 1st wave	102·2/103·2, 100·9/103·2, 101/102·7, 100·4/102·8, 100·6/—	42nd	10.50 A.M., 100°·4	$\frac{1}{600}$	+	$\frac{1}{125}$ c.c.
51	,,	40	Only now nearing end of 1st wave	99·2/101, 99/100·4, 99/100·4, 99·2/100·5, 99/—	55th	11.5 A.M., 99°·4	$\frac{1}{200}$	+	$\frac{1}{64}$ c.c.

3. Non-staining with Gram.

4. No development of gas, acidity or coagulation when grown in litmus milk, but production of alkalinity.

5. No production of acidity, but production of alkalinity when grown on glucose-litmus-agar.

6. Mobility in hanging drop merely Brownian, no translation from portion to portion of field.

7. Should be agglutinated, visibly to the naked eye by a $\frac{1}{500}$ dilution of a pure animal serum, obtained by inoculating an animal (rabbit and monkey were both used), with a pure standard growth of *M. melitensis*. Comparison with a control was always made, and the two submitted to my fellow-worker, Major Horrocks, R.A.M.C., at the next bench, and unless he concurred as to the indubitable nature of the reaction it was not accepted.

There has been considerable difficulty in extending this series of blood examinations even so far as it has gone. Patients did not like it; some consented freely, others reluctantly, and their physicians were not prepossessed in favour of it either. One would have liked to have taken a few cases and taken specimens of blood every day or every other day, and so ascertained when the *M. melitensis* appeared in and disappeared from the peripheral blood during the whole course of the fever; but it was found impossible to accomplish this. Only with one patient did I succeed in getting blood twice for examination; the first time reported as No. 6, result negative; and the second time as No. 16, result positive.

As regards syringes, I found it simplest to sterilise them in the autoclave at 120° C. The needles I found did best sterilised in pure olive oil at about 140° C.; this prevented rust and their points retained their primitive sharpness. I also found blood was obtained with greater facility if the needle were passed into the vein from the bend of the elbow towards the hand, so that blood entered the syringe in the direction of natural flow.

This method of taking blood from the median basilic vein and incubating it in broth was apparently first described by Dr. Jules Courmont, at a meeting of the Société Medicale des Hôpitaux de Paris, December 27, 1901, who applied it successfully in nine cases of Typhoid Fever in which he recovered *B. Typhosus* from the peripheral blood. I saw the method in application in Widal's Clinique in the Hôpital Cochin in Paris in the winter of 1902–3, there studied it and applied it successfully to the recovery of *M. melitensis* from the peripheral blood of Malta Fever patients in the summer of 1903. So far as I know the dilution method to determine the smallest quantity of fluid containing the micro-organism has not hitherto been applied in the recovery of micro-organisms from the circulating blood, though it is classical in the history of the bacterial analysis of water. It has

obvious advantages over the plating method, a most important one being that as in Blood No. 27, there were only nine growths representing the nine dilutions 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{128}$, $\frac{1}{256}$ c.c., to examine and put through the various tests for *M. melitensis*; whereas had 1 c.c. of this blood been plated out, it would presumably have yielded over 200 colonies, which would have required verification individually, as unfortunately all the colonies found in a blood plate are not necessarily of the same kind, and one cannot apply the principle *Ex uno omnes disce.*

Conclusions.

1. *M. melitensis* exists in the blood of patients in relatively very small amount, the smallest quantity of blood in which it has been found, $\frac{1}{256}$ c.c. is practically the equivalent of 4 c.mm. and as 1 cubic millimetre of blood = 5,000,000 corpuscles, and if *M. melitensis* is never found in association with less number of corpuscles than 20,000,000 it is obvious there is no comparison between this and such a disease as anthrax, for instance, in which in the blood the number of bacilli has been found in some cases equalling the number of corpuscles. This has an important bearing on the question of transmission of infection by mosquitoes.

2. No definite relation can be established between any given stage of the disease and the presence of *M. melitensis* in the blood. It has been found as early as the 7th day Cases 27 and 36, and as late as the 95th and 98th day Cases 1 and 14. It has been found in the majority of cases when the temperature of the patient has been raised, but it has been also present in convalescence (Case 1), and when temperature has been normal (Cases 7, 8 and 39), for several days, but it has also not been found when the temperature was high, Cases 6, 25, 28, 31, and 48.

3. There is some indication of a diurnal variation in its presence in the blood, out of 29 cases where blood was taken in the forenoon between the hours of 10 and 12.30, it was present in 14, absent in 15. Out of 22 cases where blood was drawn in the evening between 5 and 6.30 p.m. it was present in 16, absent in 6; a ratio of almost 3 : 1 in favour of the evening.

4. No relation can be established between the agglutinating power of a patient's blood for *M. melitensis* and the amount of the latter present in the blood, most of the cases in which it was found had a high agglutinating power, but one of the cases in which *M. melitensis* was found in one of the smallest quantities of blood, $\frac{1}{128}$ c.c. (Case 37) only agglutinated in a $\frac{1}{10}$ dilution, as against another in which it was found in $\frac{1}{256}$ c.c., in which there was agglutination with a dilution of 1 in 1000, and others where it was not found at all where there was agglutination in a dilution of $\frac{1}{1800}$, Cases 41, 44, and 48.

5. In some of the cases the *M. melitensis* was found to have skipped some of the dilutions, for instance, in Case 34, where the dilutions proceeded by powers of 2 from 1 to 256, *M. melitensis* was found in the 1 c.c., $\frac{1}{2}$ c.c., $\frac{1}{4}$ c.c., dilutions, absent from the $\frac{1}{8}$ c.c. and $\frac{1}{16}$ c.c. dilutions, present in the $\frac{1}{32}$ and $\frac{1}{64}$ dilutions, absent in the rest. In Blood 37, in which same series of dilutions were made, *M. melitensis* was present in all up to the $\frac{1}{64}$ c.c. inclusive, with the exception of the $\frac{1}{16}$, these were the only two cases out of the fifty-one in which this jumping took place. It is certainly not due to inadequate mixing of the dilutions, for the primary blood dilution, from the moment the blood got into it, which was instantly on the needle being withdrawn from the vein, was agitated vigorously until a considerable froth was on its surface, and so on with the succeeding dilutions. It may possibly be due to the small quantity of *M. melitensis* in the blood, or to the *M. melitensis* being in some dilutions so phagocyted as to be unable to escape and multiply.

Examination of Bloods.

Table showing in chronological order the date of the disease in each case in which blood was taken for bacteriological examination, and the result. The fractions of a cubic centimetre indicate the smallest amount of blood from which *M. melitensis* was obtained ; the sign – means no *M. melitensis* was recovered ; the days of disease which are not represented by a blood examination are shown blank. It will be seen that while many days are blank, others are represented by 1, 2, 3, or 4 examinations of blood. This has been unavoidable ; th number of cases willing to submit to venous puncture was too small to admit of selection ; and waiting a few days usually meant losing the case.

Day of disease.	Recovery and quantity or no recovery.	Day of disease.	Recovery and quantity or no recovery.	Day of disease.	Recovery and quantity or no recovery.
1		38		75	
2		39		76	
3		40		77	
4		41	—, $\frac{1}{16}$ c.c.	78	
5		42	$\frac{1}{128}$ c.c.	79	
6		43		80	
7	$\frac{1}{8}$, $\frac{1}{128}$ c.c.	44		81	
8	$\frac{1}{64}$ c.c.	45		82	
9	—, $\frac{1}{9}$, $\frac{1}{8}$ c.c.	46		83	
10	$\frac{1}{9}$, 1 c.c.	47		84	
11	$\frac{3}{4}$ c.c.	48	—	85	
12	1 c.c.	49	$\frac{9}{10}$ c.c.	86	
13	—	50		87	
14		51		88	
15	—, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{256}$ c.c.	52		89	
16		53		90	
17	—, —	54		91	
18	—, $\frac{1}{2}$ c.c.	55	$\frac{1}{64}$, $\frac{1}{64}$ c.c.	92	
19		56	$\frac{1}{4}$ c.c.	93	
20		57	—	94	
21		58		95	$\frac{1}{9}$ c.c.
22	—, —, 1 c.c.	59		96	
23		60		97	
24		61		98	$\frac{1}{2}$ c.c.
25	$\frac{1}{256}$ c.c.	62		99	
26	$\frac{1}{16}$ c.c.	63		100	
27		64		101	—
28	—, —	65		102	
29		66		103	
30	—, $\frac{9}{10}$ c.c.	67		104	
31	—, $\frac{1}{6}$ c.c.	68		105	
32	—	69	—	106	
33		70		107	
34	$\frac{1}{4}$ c.c.	71		108	—
35		72		240	—
36	1, $\frac{1}{64}$ c.c.	73			
37	$\frac{7}{8}$ c.c.	74	—		

Examination of Epidermis of Malta Fever Patients for M. melitensis.

Method.—Patients were selected with temperatures of 100° F. and upwards in different stages of the fever from the 15th to 60th day, epidermis from the arms and flanks scraped away with a sharp sterilised scalpel till the dermis threatened pin-point hæmorrhages, the scrapings put in sterilised capsules, taken to the laboratory and there ground up in a small quantity of sterile normal salt solution – (1 c.c.). From this three successive agar Petris were inoculated with one loopful, to the remainder, 5 c.c. of salt solution was added, and the surface of three other agar Petris inoculated by spreading $\frac{1}{4}$ c.c. of this diluted skin emulsion over each, and the whole incubated at 37° C. for 5 days.

Up to the present this method has been applied to twelve cases.

Discrete colonies of the different micro-organisms usually met with in the skin were obtained in every case, but in none of these plates were colonies of *M. melitensis* ever obtained.

Examination of Sweat from Malta Fever Patients for M. melitensis.

1st Method.—A skin surface of forearm washed with spirit soap, then ether, a carbolic pad 1 in 40 kept on 12 hours, then a circle of sterilised (dry 160° C. air) lint placed on this surface, and a sterilised watch glass strapped over it with adhesive plaster. After critical sweating, circle of lint removed, placed between two sterilised watch glasses held in a metal frame, and sent to me at laboratory. There each circle of lint placed in a separate broth tube numbered, dated, and incubated at 37° C. After 5 days' incubation, agar slopes, inoculated zig-zag from each, incubated at 37° C. and examined daily for growth; if sterile, original broth tubes were inoculated with *M. melitensis* returned to incubator for 4 days and then fresh slopes inoculated from them; on these *M. melitensis* invariably appeared, thus proving that sufficient disinfectant to prevent growth of *M. melitensis* had not been carried into circles of lint from disinfection of skin surface. Nineteen sweat swabs from different patients were thus examined. In some cases the tubes remained sterile, in others the agar slopes yielded growth in discrete colonies.

Result.—No *M. melitensis* was ever recovered by this method.

2nd Method.—The critical sweat was collected in sterile pipettes from four different patients, zig-zagged on agar and incubated. The collection was done by the sisters in the ward who were supplied with the pipettes ready for use, and instructed how to break off the points and apply them. They stated it was rare for sweat to collect in such large drops as to admit of collection in this manner, hence specimens were obtained from only four patients.

Result.—No *M. melitensis* was obtained.

3rd Method.—(A modification of the 1st.)—Circles of lint were obtained saturated with critical sweat from Malta Fever patients as in 1st Method, but instead of being incubated in broth tubes were placed each in a 5 c.c. sterile normal salt solution tubes, in which they were thoroughly agitated and ground up with a sterile glass rod, and the resulting fluid plated out in agar Petri dishes both by spreading ½ c.c. of it over whole surface, and by describing a centripetal spiral with a loop full of the fluid. Discrete colonies were always thus obtained after incubation at 37° C.

The critical sweats of seven patients have been thus examined without *M. melitensis* having been obtained.

To see if M. melitensis *would Pass any Filter.*

It was felt it would be of the greatest assistance in isolating *M. melitensis* if advantage could be taken of its small size to separate it from other larger organisms by means of filtration, and I, therefore, experimented with the following filters as described :—

New filters were used for the first time in each case. Obviously the first indication was to find a filter that would pass *M. melitensis* and later to see if *M. melitensis* would come through it from a mixture of microbes. Bougies were all first tested for imperfections by placing in water and applying air under pressure. *Chamberland F.* was first tried after being sterilised in the autoclave at 155° C. 1 hour. All junctions were luted with paraffin.

July 8. Placed broth emulsion of verified living *M. melitensis* from one agar slope in container, filled up with peptone broth, tightened pinch cock, placed apparatus in incubator at 37° C.

July 9. Broth in flask remains clear, loosened pinch cock and ran in 6 drops from bougie. This was repeated daily till July 30, apparatus being kept in incubator at 37° C. all the time.

July 30. Three agar slopes inoculated with some of filtrate, drawn off with a sterile pipette from flask through side tube and incubated.

August 4. No growth in any of agar slopes. Experiment concluded.

Result.—No *M. melitensis* has either been washed through or has grown through Chamberland F.

2nd Filtration Experiment with M. melitensis.

July 7. Took Chamberland F. bougie, tested for imperfections in water with air under pressure, cut off porcelain end, heated resulting cylinder to redness in moufle ; fitted up to act as filter, first sterilising all glass parts at 180° C. for 30 minutes, then sterilised apparatus in autoclave 30 minutes at 120° C., and finally luted junctions with paraffin.

July 8. Placed emulsion of living tested *M. melitensis* (emulsion in broth from growth on one agar slope) in cavity of bougie and filled up with peptone broth, removing glass rod in rubber cork to allow of escape of contained air ; replaced plug of wool in end of tube ; replaced glass rod ; and placed apparatus in incubator at 37° C.

July 9. Broth coming through filter into cavity of test-tube, displaced air escaping by tube B which had been also plugged with cotton wool.

July 27. Apparatus has now been in incubator 18 days. Inoculated three agar slopes with filtrate obtained by means of a sterile pipette passed down tube B, and placed these in incubator at 37° C.

July 31. Agar slopes have now been in incubator 4 days and remain without growth.

Result.—M. melitensis does not pass Chamberland F.

3rd Filtration Experiment with M. melitensis.

To see whether *M. melitensis* will *pass* any of three Berkefeld filters N., V., and W., of differing porosities (these were obtained from the Lister Institute).

One of each porosity was taken, tested in water with compressed air, sterilised, and fitted up, glass container being first sterilised by boiling in water and then in hot air 1 hour at 160° C. An air pass being arranged in rubber collar to allow of air displaced by filtrate escaping from container. Then the whole sterilised in autoclave at 115° C. for ½ hour.

August 7. Eight cubic centimetres of 5 days' old verified broth growth of *M. melitensis* placed in each bougie with a sterile pipette.

August 8. Some filtrate in container, 8 c.c. more of same broth culture placed in each bougie.

August 9. Five cubic centimetres more of same culture in each bougie.

August 10. Five cubic centimetres more of same culture in each bougie.

August 11. Now placed in incubator at 37° C.

August 22. Inoculated two glucose-litmus-agar slopes from contents of each container. Placed in incubator at 37° C.

September 3. No growth in any of slopes of 22nd. Experiment concluded.

Result.—M. melitensis will not pass any of Berkefeld filters N., V., or W.

4th Filtration Experiment with M. melitensis.

To see if *M. melitensis* will grow through Berkefeld filters N., V., or W.

One of each porosity taken and treated as in 3rd filtration experiment, and sterilised in autoclave.

August 14. Placed in each bougie with a sterile pipette 5 c.c. of a verified 4 days' broth culture of *M. melitensis.*

August 15. Five more cubic centimetres of same *M. melitensis* broth culture placed in each bougie.

August 16. Filters now working well; V. cylinder being one-third full of filtrate with its bougie immersed in same for ½ inch, W. and N. bougies are only just touching surface of filtrate, so 5 c.c. more of *M. melitensis* broth culture placed in each bougie W. and N.

August 17. N. receiver now half full of filtrate, bougie being

immersed for $\frac{3}{4}$ inch. More *M. melitensis* broth culture added to W. bougie only.

August 18. W. bougie now well immersed in filtrate. Placed all three in incubator at 37° C.

August 23. Filtrate in N. and W. decreasing in bulk by evaporation through wool plug. Placed more *M. melitensis* broth culture inside these two bougies. Returned to incubator at 37° C.

August 29. Broth filtrates from B., V., and W. have now been incubating at 37° C. for 11 days, bougies being immersed, and remain free from turbidity. Inoculated two agar slopes from each and placed in incubator at 37° C.

September 3. No growth in any of slopes of 29th. Experiment concluded.

Result.—M. melitensis will not grow through any of Berkefeld filters N., V., or W.

To Produce a Pure Agglutinating Serum for Testing M. melitensis (*or Growths Suspected to be* M. melitensis) *by Inoculating Rabbits with* M. melitensis.

At first, serum brought by Major Horrocks from Gibraltar, and obtained from a rabbit so inoculated, by him was used for testing all new growths thought to be *M. melitensis.* Later serum obtained from an inoculated monkey, and from the second rabbit in the following three experiments was used :—

1*st Rabbit.*

June 18. A healthy-looking rabbit was taken, of weight 1310 grammes, and its blood examined for agglutinating action on *M. melitensis.* None was found, and it was injected subcutaneously with $\frac{1}{2}$ c.c. of a 24 hours' growth of *M. melitensis* in broth at 37° C. (verified).

June 25. Agglutination $\frac{1}{10}$ under $\frac{2}{3}$ in obj.

June 28. " $\frac{1}{10}$ " and it was injected under skin of back with a 4 days' growth of *M. melitensis* on one agar slope (verified) emulsified in broth.

July 3. Rabbit found dead. *Post-mortem.* There was slight congestion of intestines, spleen, and peritoneal vessels; liver somewhat patchy, heart normal. Stomach full of green food. No *post-mortem* cultures were attempted as animal had apparently been dead 12 to 16 hours.

2*nd Rabbit.*

July 4. Verified 2 days' culture of *M. melitensis* on one agar slope at 37° C., made into an emulsion with $2\frac{1}{2}$ c.c. broth, 1 c.c. of this

injected under skin of back of a fawn and white rabbit weighing 1460 grammes.

July 13. Serum agglutinates in a dilution of $\frac{1}{10}$ *M. melitensis* faintly (microscope $\frac{1}{6}$ obj.); all growth on one agar slope (3 days) of *M. melitensis* (from spleen of man) emulsified in broth and injected subcutaneously.

July 21. Serum in a dilution of $\frac{1}{320}$ agglutinates *M. melitensis* ($\frac{2}{3}$ obj.).

July 24. Serum in a dilution of $\frac{1}{400}$ agglutinates *M. melitensis* ($\frac{2}{3}$ obj.).

July 27. Serum in a dilution of $\frac{1}{500}$ agglutinates *M. melitensis* ($\frac{2}{3}$ obj.).

Injected growth from two-agar slope of *M. melitensis* (spleen of man), July 27.

July 31. Serum in a dilution of $\frac{1}{1000}$ agglutinates *M. melitensis* ($\frac{2}{3}$ obj.).

August 4. Serum in a dilution of $\frac{1}{1000}$ agglutinates *M. melitensis* visibly to naked eye. Blood had been drawn as required from July 22 onwards.

August 8. Agglutinates *M. melitensis* $\frac{1}{1000}$ visible to naked eye; rabbit now bled to death under ether from carotid by cannula into sterile test-tubes. After separation of serum latter diluted to $\frac{1}{50}$ with sterile salt solution containing $\frac{1}{2}$ per cent. carbolic acid put up in sterile sealed glass capsules and preserved.

Post-mortem.—All organs appear healthy, spleen enlarged. Inoculated to agar slopes each from spleen, liver, kidney, heart's blood and urine.

August 11. Growth on tubes inoculated from *spleen* and *kidneys*, verified as *M. melitensis*. No growth on slopes from liver, heart's blood, and urine.

August 13. Still no growth on slopes from liver, heart's blood, and urine. Experiment concluded.

3rd Rabbit.

July 4. Verified 2 days' culture of *M. melitensis* on one agar slope made into emulsion with $2\frac{1}{2}$ c.c. broth, and 1 c.c. of this injected under skin of black and white rabbit, 11 A.M., July 4.

July 9. Serum does not agglutinate *M. melitensis.*

July 13. Serum in a dilution of $\frac{1}{10}$ agglutinates *M. melitensis* ($\frac{1}{6}$ obj. microscope). One agar tube *M. melitensis* from spleen of man emulsified and injected.

July 15. Rabbit died at 4 P.M. A *post-mortem* was made and liver found enlarged and studded with cheesy tubercles the size of peas. Other organs apparently healthy. Two agar slopes inoculated from each. Heart's blood, liver, kidney, and spleen; 2 c.c. of urine taken

from bladder with sterile pipette and put in 19 c.c. broth. All incubated at 37° C.

July 18. No growth on any of slopes; incubated agar slopes from urine broth.

July 19. Growth on slope from urine broth; found to be a short thick bacillus.

July 21. Heart's blood, kidney, liver, and spleen slopes have now been incubated 6 days. No growth on any of them. Experiment concluded.

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ST. MARTIN'S LANE.

REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART II.

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April, 1905.

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By DR. RALPH W. JOHNSTONE, Medical Inspector Local Government Board.

Brief Description of the Maltese Islands.

These islands include Malta, Gozo, Comino, and Cominetto. The two latter are islets, and, save for the hospital for exotic disease on Comino, with its caretaker, are uninhabited.

The island of Malta is about 17 miles long by 8 wide, having an area of 91 square miles. At the census of 1901 the actually resident population was returned as 176,127. This includes a garrison of about 11,000 men. There were besides about the same number of men on the fleet who were not included.

Gozo is about 9 miles by 4½, with an area of 26 square miles. Its population was 20,002 in 1901.

Both islands are covered by low hills, which, with their intervening valleys, leave little or no flat surface. In Gozo the hills are more abrupt, but in neither island is the highest point more than 760 feet above sea level. Every available inch of land is cultivated, but the fields are shut in by high stone walls, which gives the country its characteristic stony and sterile appearance. There are no rivers.

Geologically the formation is an Upper Coralline limestone, under which are successive beds of greensand and marl, overlying a Globigerina limestone (often locally called calcareous sandstone), which again overlies a Lower Coralline limestone. Practically, all the inhabited part of Malta is denuded down to the Globigerina limestone, with occasional outcroppings of the Lower Coralline formation, and one or two patches of alluvium. The north-western and more elevated part of Malta is, however, covered by the Upper Coralline limestone, as is also the higher ground in Gozo.

Part I.—General Sanitary Survey of the Maltese Islands.

Density of Habitation.—The population enumerated on land at the census of 1901 showed an average density of 1671 persons to the square mile, or in Malta 1926 to the square mile, and in Gozo 775. The population was further classified into (*a*) persons living within the fortified towns—urban area, 55,298 persons to the square mile; (*b*) persons living close to the fortified towns—suburban area, 3976 persons to the square mile; and (*c*) persons living in the districts away from the fortified towns—rural area, 749 persons to the square mile. In Senglea, a part of the urban area, the density was as high as 183,932 persons per square mile, and in Sliema, part of the suburban area, 153,297. In addition, the greater part of the rural population in Malta is housed in villages where the density of population is often higher than in many English cities—Mellieha, for instance, has a density of 147,312 per square mile. Overcrowding of houses upon area is supplemented by overcrowding of persons in houses. Taking as a standard of overcrowding more than two persons living in one room in a tenement consisting of less than five rooms, there are 27 per cent. of the total number of persons in the Maltese islands who are living in overcrowded dwellings. (The percentage in England and Wales at the census of 1901 was 12·2.) This overcrowding is largely contributed to by the number of Kerreyas, or common lodging-houses which exist, especially in the fortified towns. In Valetta, with a total population of about 24,000 persons, more than 5000 persons live in Kerreyas. The population is rapidly increasing. In the decade 1892 to 1901 the Maltese-born population increased 11·6 per cent., other British subjects 12·5 per cent., and foreigners 37·1 per cent.; while each year the population around Valetta, and its harbours, especially tends to increase in density.

Dwellings.—All the dwellings are constructed of stone, generally in two storeys with a flat roof, which is utilised to collect rain-water. In the country districts window space is usually inadequate, sometimes, indeed, altogether absent. Owing to the porous nature of the local stone, the older dwellings, where the walls are not properly protected by copings and damp-proof courses, are said to be damp in winter. Most houses have a small yard or garden, in which is found the mouth of the underground tank used for storing rain-water from the roof. The pavement of the yards is nearly always porous, and is often cracked or defective near the tank mouth, where it is most used. The yard surfaces are very often strewn with refuse and the droppings of birds and animals, or soiled with slop water; they are usually drained to the street gutter. The flooring of rooms is generally constructed of porous stone, which forms a fine dust with surface wear. Rabbits, hens, cats, and dogs are kept in the houses, and sheep and cattle are housed in out-buildings, which usually abut on the dwelling-house.

Roads.—The roads are repaired by the Government, except a few which are repaired by the military authorities. Main roads are kept in good order, but owing to the friability of the local stone used as metalling, there is much dust. Bye-roads are often almost impracticable for wheeled vehicles. In the fortified towns scavenging is done by men in the employment of the Government, and surface water drains are provided. Outside the fortified towns street scavenging is neglected.

Excrement Disposal.—The method most generally employed is what is known as the hand-flushed water-closet. This closet is usually a long hopper basin with a syphon trap below, in connection with a cesspit or a sewer. The closet is, as a rule, used for emptying excrement and slops into. It is seldom used in any other way. It is placed in the most unexpected positions, sometimes in the open yard in a niche in the wall, frequently in the kitchen a foot or two from the cooking apparatus, or it may be in a small cupboard ($1' \times 2'$ usually) in the external wall of the house, or in the steps leading to the entrance hall from the front door, and sometimes even in the open street. It is very exceptionally found in a special room or in a position where it is likely to be used in the usual manner. In those poorer class houses which have got a special room for the water closet, the room serves often also as a larder or food store. The hand-flushing of these closets is conspicuous mainly by its absence. Water has always been a precious commodity in Malta, and is used sparingly; in addition cesspits are emptied at the owner's expense, at the high rate of 1*s.* 6*d.* per 100 gallons. The consequence is that one rarely sees a water-closet basin even moderately clean. They are usually caked with filth, and the surroundings fouled with fæcal matter. Again, when a poor proprietor owns a field or garden, he often ceases to make use of the closet, in order to avoid the cost of emptying, or because he values the excrement as manure. As result, the water in the trap evaporates, and cesspit or sewer air gains access to his premises.

The next most frequent method is what may be called the misbla system. A misbla is a dung heap, and it may be placed in the garden or yard, or more frequently in an outhouse adjoining the living rooms, or in an ordinary room in the house. Here all the excrement of the family is carefully preserved for removal to the fields. The abominable stench that may be caused in a dwelling by this system is not easily described. Occasionally a cellar is used as a misbla, and privy seats are placed in the room above. The vessels which are used to convey excrement from the bedrooms to its destination are often left in the house unemptied for several days. On one occasion on asking to see the vessel used for conveying excrement to the garden, I was shown the bucket in which the vegetables for the family dinner were being washed.

There are a few privy middens, and a few modern properly flushed water-closets. The garrison are provided with trough latrines, flushed once or twice a day, but owing to the feebleness of the flush and the defective pattern of latrine used, were often found overfull and offensive. In places where the latrines were flushed by a rush of water through the trough, a filthy and offensive residue was left behind after the flushing, and in places where the basins were flushed from above into the trough, the feeble trickle of water provided was entirely inadequate. The wooden seats of the military latrines are constructed a few inches above the iron surrounding the opening to the basin, with the result that urine is liable to soil the flat iron surface and dry there, after which the dried residue may be blown about by currents of air.

The naval latrines, or "heads," on board ship are of a better pattern, better flushed, and lack the iron cover underneath the wooden seat. The officers' water-closets, which are used also as urinals, are, from their height above the floor, peculiarly liable to contamination of the floors with urine.

Little effort is made to prevent the pollution of open spaces and walls by excrement and urine. The spaces around the landward fortifications of Floriana are especially liable to fouling, on account of the habits of the country people who pass every day into Valetta. Public urinals sometimes have no water supply, and thus become very offensive.

House Refuse Disposal.—There is no regular system for collection of house refuse in Malta. Certain men with carts call at the houses in the morning and take away house refuse for use as manure, but they are in no way bound to take it, and instances arise where they decline to remove refuse containing material not likely to be useful, such as tin cans and broken bottles. Ash-pits or bins are almost unknown. Refuse is thrown into the garden or into the street. Dead animals, vegetable refuse, and other filth may often be seen in the streets, and many complaints have been made by the better class inhabitants on this score. The police, however, seem powerless to enforce their regulations in the matter.

Owing to the lack of proper flushing the house drains and soil pipes become caked with filth, and complaints of smell arising from the inlet ventilators of house drains are frequent.

Sewers.—In some of the towns, for in Malta the villages are really small towns, quite compact and lacking in open spaces, there are sewers which have existed for centuries. They are built of, or cut in the porous rock, being more in the nature of galleries than sewers, and they are not in any way rendered impervious. They act as elongated cesspools where the liquid sewage gradually soaks away into the rock, leaving a semi-solid residue. Such, for instance, is the system at Birchirchara, Victoria, and formerly at Curmi.

Modern sewers exist at Valetta, Cospicua, Senglea, Vittoriosa, Calcara, Misida, Curmi, and Sliema, and are in course of construction at Notabile and Rabato, and at Hamrun. Many of the houses abutting on the harbour still drain into it, so that when the fleet is in, and many ships are discharging their sewage into the Grand Harbour, the water is liable to become visibly polluted with excremental matter. Since there is very little tide, this may become a serious nuisance.

Cesspits, in the case of new houses, are built under the street and are ventilated and cemented. In the old houses the cesspits are often under the dwelling rooms and unventilated. Very frequently they are placed close to the water tanks. Many old cesspits are never emptied, since they are not impervious, and it is to be feared that new cesspits are occasionally tampered with so as to render them pervious, after they have been passed by the sanitary authority. Cesspits are emptied by means of a pumping engine into iron tank carts. The contractor who undertakes this work is empowered to charge at the rate of 1*s*. 6*d*. per 100 gallons.

Water Supply.—There is a public water supply laid on to every village in Malta except Mellieha. The water is derived from groups of springs in three different localities, which afford an approximate mean daily yield of 418,500 gallons by gravity. In addition, there are three other sources from which potable water is pumped, the mean daily yield being about 693,000 gallons. Besides the drinking water there is a brackish water found at Armier, and pumped to Valetta, where it is used for watering streets and flushing sewers. The main storage reservoirs for drinking water are at Ta Kali, near Attard, and are capable of holding 16,865,200 gallons. The total storage capacity of the island is 18,980,000 gallons. The gathering grounds for the water supply are for the main part in thinly populated portions of the island. The water is collected in galleries driven in the rock deep below the surface, and conveyed by iron pipes to the tank or pumping station. From there it is distributed by cast-iron pipes or by stone channels built in, and lined with cement. The water is usually distributed by means of stand-pipes in the villages. In Valetta the houses generally have taps, but they are often without them, and outside the area surrounding the harbours taps are seldom found in the houses. In some villages there are large underground tanks provided by the roadside, which are filled in the winter from the public water supply. These tanks are seldom fitted with pumps, and in consequence become very foul from the constant lowering into them of buckets which have been allowed to stand on the roadside. The vicinity of pervious cesspools provides a possibility of pollution which is often present.

Practically every house in Malta has underneath it a large tank for collecting rain-water from the roof. This water is generally preferred to the public water supply for drinking, possibly because it is cooler

in summer. The contents of these tanks very often show signs of pollution, nor can this be wondered at when it is considered that the roof is very much used by the family in summer, and by their cats and dogs. Tanks are never supplied with pumps, and the bucket which is lowered into them by a rope is often placed on the yard flags amidst slop water and pollutions due to animals or to the neighbouring water-closet. There are very few wells in Malta.

In Gozo the public water supply is obtained from similar sources to that of Malta, the total mean daily supply amounting to about 143,000 gallons, derived from three principal sources. About 90,000 gallons of this water, coming from two sources, is brackish, and about 50,000 gallons, coming from the other source, is good water. The two qualities are mixed before distribution, and the result is a water containing considerable quantities of magnesium salts, which is liable to affect new comers prejudicially.

In the villages of Xahra and Nadur there are wells, a few also being found in Victoria; but elsewhere the usual rain-water tank system prevails, and is liable to the same dangers as in Malta.

All the villages in Gozo except Xahra, Zebbug, Nadur, and Kala have the public water supply, and Nadur is about to be supplied.

Hospitals.—There is a hospital for infectious diseases in connection with the Lazaretto on Manoel Island. It is intended for the isolation of small-pox, scarlet fever, diphtheria, and erysipelas. The buildings are out of date.

The Central General Hospital is at Floriana. It has 226 beds, including the Seamen's Hospital, which adjoins it. It receives cases of enteric and Mediterranean Fever, besides surgical and other cases. No attempt is made to isolate the Mediterranean Fever cases from the others. The methods of this hospital in the matter of cleansing the patient and disposal of the contents of bed-pans of enteric and Mediterranean patients are unsatisfactory. Reference will be made to this matter later. There is no proper hospital sink, and the laundry is inadequate. All infected clothing is despatched to the poor-house laundry. It is said to be steeped in corrosive sublimate solution before being sent, but I saw no signs of the process at my visit, except some barrels containing water, which were shown me as the receptacles used for steeping. There is a general hospital at Citta Vecchia, known as the Santo Spirito Hospital, containing some 70 beds, and there is a similar institution in Victoria, Gozo, with about 60 beds.

The quarantine hospital on the island of Comino is well isolated. It is intended only for ship-borne cholera, yellow fever, or plague.

There is a large building at Marfa, well isolated, which is intended to serve for cases of exotic disease amongst the inhabitants of Malta.

The military hospitals are seven, six in Malta and one in Gozo. The Station Hospital, Valetta, accommodating about 200 patients, is the

ancient hospital of the Knights of St. John. The building is unsuitable for a modern hospital. It contains no hospital sink. Attached to it is the hospital of the Royal Malta Artillery.

The Royal Naval Hospital at Bighi contains about 200 beds.

Sanitary Administration.—There is a Council of Health, consisting of twenty members, six of whom are medical men. It is their duty to advise the Government on sanitary regulations, on quarantine measures, on public works in connection with hygiene, including drainage and water supply, and on all other matters of public health. The Council has power to suggest measures, inquiries, and scientific investigations in connection with public health. The Council meets every two months.

The public health department is directed by the Superintendent of Public Health, Mr. R. P. Samut, M.R.C.S. Eng., who receives £400 per annum. It is his duty to watch over and direct the medical officers of health, the sanitary inspectors, and all other officers of the department, and to advise them. He has also to inspect at intervals the hospitals, quarantine establishments, slaughter-houses, charitable institutions, prisons, etc. Finally, he has to advise the Governor, when required, on public health questions, and he has to draw up an annual report on the sanitary state of the islands, and send it to the Governor.

The Superintendent of Public Health thus reports direct to the Governor, and the functions of the Council of Health are purely advisory, or at most suggestive. The Superintendent solely is responsible for the annual report. His position is one of great responsibility, demanding experience and a high degree of expert knowledge.

There are two medical officers of health for Malta—Dr. Caruana Xicluna, who receives £350 a year, and Dr. F. Xuereb, who receives £250. These gentlemen divide their duties—the first-named superintending buildings, zymotic diseases, foods, shops, and noxious trades, while the latter looks after drainage, notifications, isolation, disinfection, and overcrowding.

There is a medical officer of health for Gozo—Dr. E. Calleja, who receives £120 a year. The Sanitary Engineer, Mr. C. Mallia, receives £170, with £30 additional as superintendent of drains. There are 18 sanitary inspectors in Malta, receiving about £60 a year each. In Gozo there are four, who receive salaries on the same scale. There is an inspector of markets, who receives £110 a year; Mr. MacFarlane, M.R.C.V.S., who superintends the slaughter-house, receiving £30 a year.

There are 22 district medical officers in Malta, and four in Gozo. Up to 1885 these officers received £10 a year for certain public health duties; but since then each of them receives a lump sum varying from £60 a year to £140 a year to cover all their duties, which are in the main the same as those of our poor-law district medical officers. They

also perform vaccination twice a year free of cost. Their public health duties are to inspect infected premises, and determine whether the patient must be removed to hospital or not; to inspect bad food if called in by a sanitary inspector, and to inspect midwives once a month, and see that their equipment is adequate and clean.

The district medical officers are under the control of the Comptroller of Charitable Institutions, as are also the hospitals and other charitable institutions.

There is a public analyst and bacteriologist, with two assistants. Dr. T. Zammit has held the post since January, 1891.

The annual report of the public health department has of late years been very disappointing. Formerly it contained comments and suggestions, but it is now merely statistical and conveys little information as to the conditions which exist and have to be dealt with by the department.

Some of the sanitary inspectors are hard-working, intelligent men, who know their districts; but not a few are entirely ignorant of the elements of sanitation, and in some cases even of the conditions prevailing in their districts. Close supervision and drastic weeding out is required amongst them. The Government have made a new departure this year in sending three young men to England to be trained as sanitary inspectors. They are to be followed by others if the experiment prove successful. I have great hopes that it will. Some of the sanitary inspectors make house-to-house inspections daily, but others never do so unless a case of infectious disease arise. The poorer people are too ignorant of sanitation to make complaint, so that without frequent inspection grave conditions may be allowed to exist for long periods. The public health department have issued a general order to the sanitary inspectors not to report faults in drainage unless urgent, on the grounds, I was informed, that all the villages would some day be sewered. The order is liberally interpreted by many of the inspectors, and was quoted to me in extenuation of such conditions as cesspits ventilated into living rooms, sewers ventilated into houses by unsealed water-closets, leaky cesspits, etc.

There is a sanitary commission appointed by the Governor for the maintenance and construction of drainage. The Superintendent of Public Works is chairman, and there are six other members, four of whom are medical men.

Notification of Infectious Disease.—There is no payment for notification, and though there is a penalty for neglect to notify, it is difficult to exact, and in point of fact never has been exacted. Many considerations interfere with the accurate notification of Mediterranean Fever. For instance, persons who die of it are not permitted burial in a church, a cherished privilege outside the fortified towns, or a private practitioner wishes to spare his patient the annoyance and

expense of lime-washing and disinfection. In addition, the diagnosis is often difficult, the serum test not generally being applied. The consequence is, only severe cases are notified, and not always these. In the official record of the notifications, the age and sex of the patient is generally unrecorded; in many instances even the name is not recorded, nor the number of the house.

A Maltese medical man of experience told me he did not think more than a third of the cases of Mediterranean Fever that occurred in Malta were notified, and not more than a fifth of those in Gozo. I think this estimate is not far wrong. In addition, I found that many English cases attended by Army doctors were not notified.

The following diseases are notifiable:—Plague, cholera, yellow fever, small-pox, scarlet fever, diphtheria, diphtheritic croup, typhus fever, enteric fever, measles, remittent fever (Mediterranean), febrile puerperal diseases, continued fever (on 7th day), erysipelas, epidemic spinal meningitis, chicken-pox, influenza, whooping cough.

Disinfection.—The usual means adopted are fumigation by burning sulphur, soaking washable materials in corrosive sublimate solution, and lime-washing. Bedding and other articles unsuitable for soaking are not sent to the steam disinfector in cases of Mediterranean Fever, seldom indeed in any disease.

Isolation.—Small-pox and diphtheria are isolated, and the early cases in outbreaks of measles or scarlet fever. The routine adopted in these diseases is as follows:—The case is visited by the District Medical Officer, who reports whether it can be isolated at home or not. If it can be isolated at home, a man is sent to act as health guard, whose business it is to prevent communication between the sick room and the public. If the case has to be removed, a police sergeant is sent with the ambulance.

Mediterranean Fever is not isolated.

Sanitary Law is embodied in ordinances enacted by the Governor with the advice and consent of the Council of Government. They cover much the same ground as our own public health laws, though some of the Maltese ordinances are more stringent. They include regulations as to noxious trades, bake-houses, milk-shops,* buildings, markets, refuse in streets, etc.†

There is a quarantine medical officer, with three assistant medical officers, and a veterinary surgeon.

* The usual source of milk in Malta is the goat. These animals are driven about the streets in flocks, and are milked at the customer's door into his own vessel. The udders, which are abnormally large, often touching the ground, are very liable to be soiled. The proprietors of herds are so many that it is always difficult to ascertain from a householder where he has got his milk. No regulations are in force for the effectual control of these vendors.

† The regulation against throwing refuse and offal into the streets is not enforced, or very feebly so.

Part II.—Mediterranean Fever.

Introductory.—I do not propose in this report to deal with the history and literature of Mediterranean Fever, or with its symptoms, treatment, or distribution outside Malta, except very briefly, and in so far as these have a direct bearing upon my own part of the work of the Commission.

The study of Mediterranean Fever, virtually commenced by Marston's paper in 1861, received its great impetus from the discovery of the *Micrococcus melitensis* by Bruce in 1887. After this, for many years the difficulty of diagnosis caused by the strong resemblance between this fever and other diseases endemic in Malta, such as enteric fever and the fever known as "simple continued," retarded investigation and detracted from the value of the figures recorded.

In 1897, Wright and Semple, by introducing the serum agglutination test, placed matters on a more exact basis. This method was in 1900 adopted as a routine practice in the Army, and shortly after in the Navy.

Since the publication of Hughes' book in 1897, Mediterranean Fever has attracted considerable attention in the Army and Navy, and much has been written about it. With the exception of Zammit's paper in 1902, little appears to have been done in the way of studying its behaviour amongst the civil population of Malta, either by the local medical men or by others. It was partly for this reason that I devoted most of my attention, during my stay in Malta, to the disease as it occurred amongst the Maltese.

From the outset I found myself confronted by two difficulties, the first, a badly administered system of notification, which has been already referred to in Part I of this report, and closely allied with it considerable unreliability of diagnosis, due partly to the fact that the serum agglutination test is not generally in use in Malta outside the Army and Navy, in spite of the facilities afforded by the Bacteriological Laboratory at Valetta. My second difficulty was the fact that very few Maltese speak English, and that their natural politeness leads them generally to try and give the reply they deem most likely to please, and not that which is most scrictly in accordance with the facts. Add to this a strong distrust of the sanitary authority, whose objects they are in general unable to understand, and whose visits they regard solely as a probable source of expense to themselves in the way of white-washing or cleansing, and it will be understood that accurate information was not always easy to come by.

The Geographical Distribution of Malta Fever will be of importance in the future study of the conditions which favour the spread of the disease.

The following list of places, from which Mediterranean Fever has been reported, is taken, with slight additions, from the "Journal of the R.A.M.C.," vol. ii, No. 4 :—*Spain*—Gibraltar ; *Islands of the Mediterranean*—Balearic Islands, Corsica, Sardinia, Sicily, Malta, Gozo, Cyprus, Crete ; *Italy*—Rome, Naples, Caserta, Benevento, Campobosso, Aricca, Terano, Fermo, Padua, Cittanova, etc. ; *Greece*—Athens, Cephalonia ; *Turkey*—Constantinople, Smyrna ; *Palestine*—Jerusalem ; *Africa*—Tunis, Algiers, Alexandria, Suakin, Massowah, Zanzibar, Kimberley (?) ; Aden ; *India*—Calcutta, Mian-Mir, Nowshera, Secunderabad, Simla, Delhi, Lucknow, Agra, Allahabad, Choabattia, Subatha, Assam, Swat Valley ; *China*—Hong-Kong, Philippine Islands, Fiji Islands ; *North America*—Mississippi Valley ; *West Indies*—Cuba, Puerto Rico ; *South America*—Venezuela, Brazil, Montevideo.

This list will probably undergo considerable enlargement and alteration in the future, and I will only say in connection with it that there are factors which I am not in a position to take into account, such as the reliability of the diagnosis or of the cultures by means of which the diagnosis has been confirmed, and the fixing of the place where infection took place, having regard to the prolonged liability to relapse.

Hitherto, Mediterranean Fever has not been reported north of the 45th parallel or south of the 40th.

Incubation Period.—The general impression amongst Maltese medical men seems to be that the usual incubation period of Mediterranean Fever is not more than 8 or 10 days.

The following cases have occurred in the course of laboratory work with the *Micrococcus melitensis* in places where there was no prevalence of Mediterranean Fever and no apparent source of infection other than in relation with infective material in the laboratory :—

	Incubation period.
1.—S. From an accidental prick with a syringe needle which contained a living culture	15 days
2.—W. From purposeful hypodermic injection of a living culture	16 ,,
3.—B.S. From accidentally drawing into the mouth a small quantity of living culture through the mouth	8 ,,
4.—E. From the same kind of accident as 3	6 ,,
5.—S. From accidental wound of the conjunctiva with a portion of a broken tube which had contained living culture*	5 ,,

Besides the above, Fleet-Surgeon Bassett-Smith has informed me of

* In this case, examination by an oculist, soon after the breakage of the tube, failed to disclose any wound of the conjunctiva.

another laboratory case in which the occasion of inoculation could not be traced.

The five cases given above are too few to afford sufficient basis for trustworthy induction. They are, moreover, open to the objection that infection did not necessarily take place on the occasions cited, but may have occurred at some other time in the course of work with infective material. But after due allowance made for the latter consideration, No. 2 is to be regarded as of materially greater value as a guide to the incubation period of Mediterranean Fever than any of the others, since, in this instance, there was a definite and purposeful introduction into the system of a presumably sufficient amount of living culture of *Micrococcus melitensis*, accompanied by record of the time of such introduction, and by subsequent outlook for the first appearance of illness. The remaining four cases, which are marked by considerable diversity in respect of the incubation periods inferred, are more open to challenge, and, therefore, afford less trustworthy guidance in this matter than does No. 2.

I have made inquiry with a view to finding how many cases of Mediterranean Fever have been observed to occur on board our ships of war after leaving a Mediterranean port and before touching at another Mediterranean port.

Fleet-Surgeon Bassett-Smith has kindly examined his records and sent me 13 cases which occurred on board ship, but none in which it could be confidently said that the fever occurred more than 14 days after leaving the last Mediterranean port of call. He included three cases in which Mediterranean Fever occurred three weeks after the ship left Malta, but he was unable to say she had not subsequently called at a Mediterranean port before the onset of the fever. He also included a case in which Mediterranean Fever occurred 12 months after leaving the Mediterranean, but said that the patient had a slight attack of fever while on the Mediterranean station, so that the possibility of a relapse cannot be excluded.

Fleet-Surgeon Bassett-Smith also sent me the following remarkable case:—A. B. left Gibraltar December 20, 1903, having had no attack of fever at the time and feeling quite well. He arrived home for Christmas, went on leave for a month, and then took on duty attached to the "Excellent" gunnery establishment at Gosport. About February 20, 1904, acute fever set in, for which he was sent to the Royal Naval Hospital, Haslar, as a case of enteric fever. His blood was examined in the first fortnight, and gave a negative reaction for enteric, but a positive for Mediterranean, and later on the *Micrococcus melitensis* was isolated from his blood. This case must have had an incubation period of two months if it be conceded that infection occurred in the Mediterranean. There is the possibility that he was infected from some unrecognised case at Gosport, but this possibility

is largely discounted by the fact that many cases of Mediterranean Fever are annually treated at the Royal Naval Hospital, Haslar, without any recorded spread of infection. The case, though exceedingly interesting, will be of greater value in the consideration of the incubation period of Mediterranean Fever, should other like cases occur hereafter; at present it stands alone.

From Staff-Surgeon Gilmour I received record of eight cases which occurred on warships at sea, and two others I saw myself in Malta, but none of them occurred more than 14 days after the ship had touched at a Mediterranean port.

Ships while on the Mediterranean station are seldom or never more than a few days without touching at a port, so that their records are unlikely to afford any guidance until they leave the station for home.

I received from Lieutenant-Colonel Rhodes, R.A.M.C., details of a search which he caused to be made, at my request, in the records of the R.A.M.C. at Malta for the period January 1, 1901, to August 31, 1904. During that time only two cases could be found in which Mediterranean Fever had occurred less than 14 days after the patient's arrival in Malta. The first case was a Munster Fusilier, who was admitted to hospital suffering from Mediterranean Fever on February 22, 1901, eight days after the regiment's arrival in Malta, from England. The second case occurred in the Sussex Regiment, and was admitted to hospital on July 7, 1904, 11 days after the regiment's arrival in Malta, from England.

Further evidence is required before a definite average incubation period can be established. It may, however, be provisionally stated that the data available tend, in some degree, to suggest that the incubation of Mediterranean Fever ranges about a period of 14 days.*

Distribution of Mediterranean Fever in the Maltese Islands.

Mediterranean Fever occurs in every part of Malta and Gozo, on the sea coast and inland, though as a rule its relative incidence is less severe in the villages more remote from the capitals.

The figures given below with regard to cases have been abstracted from the civil official notification returns, where Mediterranean Fever is generally notified under the name of remittent fever. There are in these returns numerous cases notified under the name continuous fever. These Zammit has included in his returns as Mediterranean Fever cases. His grounds are that in Malta all fevers lasting more than a week are notifiable by law, and since all the named fevers—

* Bruce says that cases have occurred in as short a time as 6 days after arrival in Malta. Hughes, while stating his belief that the incubation period is sometimes as short as 3 days, considered that 10 to 15 days is the most usual time.

such as enteric, etc., are notified separately under their proper headings, the residue returned as continuous fever are in reality Mediterranean Fever. He does not, however, reckon with the fever known as "simple continued fever," the most common form of illness in Malta during the hot weather, or else he does not consider that simple continued fever commonly lasts more than a week.

I have examined the records of the naval hospital in Malta, where the diagnosis is at least as careful as in Malta generally, and I find that during the five years 1897 to 1901 the average duration of cases returned under the heading "Other Continuous Fevers" is over eight days. Practically, all these cases must have been "simple continued fever," since Mediterranean Fever, enteric, malaria, and other named fevers are placed under separate headings. I think it, then, more probable that the majority of the cases noted in the Maltese notification returns as continuous fever were cases of "simple continued fever" than that they were cases of Mediterranean Fever. I have, therefore, included in tables dealing with cases of Mediterranean Fever only those cases which were entered in the Maltese notification records as remittent fever, or as Mediterranean Fever.

Table I (pp. 18 and 19) shows the number of cases of Mediterranean Fever which occurred in each of the districts of Malta and Gozo amongst the civil population during each year of the period 1894 to 1903, together with the mean estimated population of each district during the same period, the average number of cases of Mediterranean Fever per 10,000 of population per year, and the number of deaths from Mediterranean Fever during the whole period.

The very general distribution of Mediterranean Fever throughout Malta is perhaps the most striking feature of this table. It will be seen, too, that it is by no means the localities closest to the harbours which suffer the most severely. Hamrun, a somewhat squalid suburb, and the combined villages of Lia, Attard, and Balzan show the heaviest incidence, while Valetta and the three fortified towns, Cospicua, Senglea, and Vittoriosa, are amongst the least severely attacked. In some respects, however, the latter four places cannot fairly be compared with the remainder of the island. All four towns are paved, drained, and scavenged, a state of affairs not found in any other part of the island.*

Disregarding Valetta and the three fortified towns above mentioned, it will be found that the severity of incidence in Malta depends roughly on the amount of the population. The average incidence throughout

* Floriana is drained but not paved, and the scavenging is not so well carried out as in Valetta; moreover, a vast number of country people pass through it each morning to reach Valetta, and complaints have been made that they use the fortifications around Floriana as a latrine. Curmi was sewered in 1901, Sliema in 1902, and Misida and St. Julians in 1903.

Malta as a whole, is 32 cases per year per 10,000 of population, and the average for places other than the four towns first mentioned is 37·8, neglecting the cases which occurred in public institutions. The average number of inhabitants for each of these places is 4240. Twelve of them contain more than 4240 persons each, and in 8 of the 12 the average incidence is greater than 37·8. Fourteen districts have less than 4240 inhabitants, and in 12 of them the average incidence is less than 37·8 per 10,000. The mean incidence on the group with over 4240 population is 41·6 per year per 10,000 during the 10-year period, while that upon the group with less than 4240 population was for the same period 26·7 per year per 10,000. This is no doubt a very rough classification, and there are notable exceptions, such as Curmi. On the other hand, the notification returns dealt with are not sufficiently reliable to justify any but the most general groupings, perhaps not even these. The classification, such as it is, would tend to show that, outside Valetta and the towns named, the greater the aggregation of inhabitants living in one locality, the greater is the proportional number of cases of Mediterranean Fever that occurs amongst them. The returns from Gozo do not show the same result, but then the numbers dealt with are smaller and the returns themselves probably more inaccurate than in Malta.

Density of population upon area outside Valetta, Cospicua, Vittoriosa, and Senglea appears to have some influence on the incidence of Mediterranean Fever. Floriana, Hamrun, Misida and Pietá, Sliema, Zeitun, and Mellieha are the most densely populated, all having more than 100,000 persons to the square mile. With the exception of Mellieha, and in a lesser degree Zeitun, these places all have a case incidence above the average. On the other hand Zebbug, Siggeui, Axiak, Gudia, Chircop, Safi, Zurrico, and Krendi are the least densely populated, each having less than 30,000 persons per square mile, and the proportional incidence on all these places, except Zebbug, is less than the average.*

For purposes of comparison, it has been customary for some years past to divide Malta into three areas—(1) *an urban drained area*, comprising Valetta, Floriana, Cospicua, Vittoriosa, and Senglea; (2) *a suburban undrained area*, comprising Misida, Pietá, Sliema, St. Julian's, Hamrun, Birchirchara, Curmi, Zabbar, Tarxien, and Paola; and (3) *a rural area*. Comparing the three areas for the period 1894 to 1903, it appears that the average number of cases of Mediterranean Fever per year per 10,000 inhabitants was—

(1) Urban drained area	18·8
(2) Suburban undrained area	41·8
(3) Rural area	33·4

* It will be seen later, when considering the maps, that density of population upon area in parts of districts, does not show the same influence.

Table I.

—	Number of cases of Mediterranean Fever notified.											Mean estimated population during the period 1894–1903.	Average number of cases of Mediterranean Fever per year per 10,000 of mean estimated population during the period 1894–1903.	Number of deaths from Mediterranean Fever during the period 1894–1903.
	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	Total.			
Malta—														
Valetta	17	16	52	22	25	39	44	49	46	30	340	23,052	14 ·3	53
Floriana	16	7	34	28	18	43	31	28	27	38	270	5,910	45 ·7	20
Misida and Pietá	5	1	3	20	19	26	21	24	60	29	208	3,648	57 ·1	6
Sliema and St. Julian's	44	24	53	57	33	55	43	42	67	52	470	10,856	43 ·3	39
Hamrun	4	38	71	86	73	92	81	104	34	24	607	9,364	64 ·8	26
Cospicua	6	3	74	27	12	16	9	21	8	25	201	12,128	16 ·6	31
Vittoriosa	1	6	7	13	37	33	26	14	13	14	164	7,162	22 ·9	16
Senglea	—	1	30	14	11	7	2	4	8	7	84	8,012	10 ·5	10
Notabile and Rabato.	14	5	8	17	32	76	14	16	36	25	243	8,045	30 ·2	36
Dingli	—	—	—	—	—	4	7	3	16	—	30	759	39 ·5	2
Zebbug	3	24	53	17	18	13	68	19	28	47	290	5,416	53 ·5	21
Siggeui	2	—	4	10	16	33	8	3	6	4	86	3,192	26 ·9	9
Birchirchara	10	28	30	25	37	103	67	58	41	42	441	8,144	54 ·2	42
Lia, Attard, and Balzan	38	27	58	19	12	52	25	35	31	33	330	4,522	73 ·0	20

Naxaro	6	6	6	15	4	16	11	21	10	14	109	3,443	31 ·7	6
Musta	5	3	12	3	32	27	34	24	27	24	191	4,675	40 ·9	27
Gargur	—	—	—	10	—	3	7	1	6	4	31	1,355	22 ·9	5
Mellieha	—	—	3	—	5	2	7	5	3	1	26	2,233	11 ·6	4
Curmi	2	—	1	2	4	3	5	17	8	6	48	7,994	6 ·0	9
Luca	—	—	1	—	2	—	3	2	6	12	26	3,318	7 ·8	5
Tarxien and Paola...	6	7	7	8	5	16	3	8	24	17	101	4,476	22 ·6	15
Zurrico	6	3	13	11	12	22	8	4	5	3	87	3,589	24 ·2	8
Safi..............	—	2	2	2	—	2	—	1	2	2	11	350	31 ·4	1
Krendi.............	1	—	7	7	6	5	1	1	1	—	31	1,559	19 ·9	5
Micabiba...........	1	1	10	3	2	2	—	—	2	2	23	1,192	19 ·3	1
Chircop............	—	3	2	—	3	1	1	1	1	2	14	619	22 ·6	1
Zeitun.............	55	14	31	44	10	8	17	14	7	22	222	7,492	29 ·8	12
Zabbar.............	47	7	29	18	17	18	14	24	13	27	214	5,549	38 ·6	20
Axiak	9	3	5	1	2	1	4	6	1	1	33	1,493	22 ·1	1
Gudia	3	2	9	3	2	3	4	—	—	4	30	1,141	26 ·3	1
Public institutions...	9	16	15	13	6	27	43	23	14	7	173			
Total	310	247	630	495	455	748	608	572	551	518	5134	160,603	32 ·0	452
Gozo—														
Victoria............	4	11	12	4	9	10	2	6	—	13	71	6,101	11 ·1	3
Garbo	—	—	1	—	—	1	3	—	—	—	5	1,708	2 ·9	5
Zebbug	—	—	—	—	1	2	—	—	1	1	5	1,166	4 ·3	—
Sannat.............	—	—	—	2	7	7	8	—	—	1	25	1,093	22 ·9	4
Xahra	3	2	2	51	28	18	22	13	5	2	146	2,509	58 ·2	7
Xeuchia	—	—	—	10	6	2	2	7	7	9	43	1,718	25 ·0	2
Nadur and Kala	2	1	—	1	—	3	1	24	14	7	53	4,079	13 ·0	7
Ghainsielem	—	—	2	—	1	1	—	3	10	1	18	1,106	16 ·3	2
Ospizio	—	1	—	—	—	5	2	—	—	1	9			
Total	9	5	17	68	52	49	40	53	37	35	375	19,480	19 ·2	30

Considerably below the average number of cases occur in the urban area, and considerably above the average in the suburban area, while the rural area suffers in much the same degree as Malta taken as a whole.

The urban area is better drained and paved, scavenging is more efficiently carried out, and it has more public conveniences than other parts of the island. On the other hand, there is in the urban area equal or greater aggregation of persons in one locality, and more overcrowding upon area. There is no marked difference between the urban and suburban areas as a whole in the matter of the wealth and station of their inhabitants. Parts of Valetta such as the Manderaggio contain the very poorest of the population, and these parts do not appear to suffer out of proportion to their numbers. The three cities also have many very poor inhabitants; but Sliema and St. Julian's are probably the most wealthy and fashionable parts of the island.

There are some stumbling blocks in the way of all attempts to generalise from the table above. The most striking is the difference in the incidence upon Curmi and upon Birchirchara. These two towns, for they are really small towns rather than villages, are situated close together, on the same kind of soil, with the exception that a part of Curmi is on alluvial soil. They contain about the same number of inhabitants, and the same kind of houses, any difference being that there are more good houses in Birchirchara, yet the incidence of Mediterranean Fever upon the latter has been nine-fold as great as upon Curmi during the period 1894 to 1903. I have examined these villages from many points of view, but I have hitherto found nothing that would account to my mind for the difference. It may be that the personal factor is of unusual weight here in the matter of notification. I hope, however, to have some more facts to consider in this connection when the returns which are now being collected in Malta are due for examination.

I prepared a map for the purpose of studying the distribution of Mediterranean Fever during the period January 1, 1899 to July 31, 1904, in Valetta and Floriana respectively.

In Valetta there is no marked aggregation of cases in proportion to population. The apparent aggregations of cases in the Manderaggio, in Strada S. Giuseppe, and in Str. Pozzi are due simply to the fact that these localities are very thickly populated, consisting mainly of houses each of which contains many families—"Kerreyas" or common lodging-houses. I was informed, for instance, that about 3000 people live in the Manderaggio.

In Floriana, also, most of the groupings of cases are due to cases occurring in different families living in the same "Kerreya." There is, however, a remarkable immunity from attack noticeable in Piazza

Maggiore, Piazza Britannica, and Strada Giardino, all of which face on to broad open spaces, and consist in the main of better class houses. This may be partly explained by the fact that the English doctors do not as a rule comply with the notification law. Most better class streets in Floriana, Sliema, and St. Julian's are occupied to a considerable extent by English people, who are generally attended by English doctors.

Another map showed the distribution of Mediterranean Fever in Hamrun during the period January 1, 1892 to July 31, 1904. Here there are not so many "Kerreyas," and in consequence there is less apparent grouping of cases than in Valetta and Floriana.

A third map showed the distribution of cases during the same period in Sliema. Mediterranean Fever cases here show a distinct preference for the southerly slope towards Sliema Creek as opposed to the northern slope towards the open sea, and the houses in Strada It-Torri, which face the sea, seem to have escaped attack. But many of these houses are occupied by English people, and in any case the streets running down to Sliema Creek are much more densely inhabited.

My maps of Misida and Pietá proved valueless, because the notification returns left so many houses unindicated, the names of the streets only being given.

The other maps in my possession serve only to show the same lack of definite aggregation of cases around a particular centre.

The following table shows the distribution of Mediterranean Fever during the period 1901 to 1903 in the Mediterranean Fleet, including such of His Majesty's ships as have called at Malta in passing through the Mediterranean Sea during that period. (Table II.)

Many of the cases occurred on board ships at considerable intervals of time from the vessel's last call at Malta, and it seemed useful to attempt some discrimination between cases that were possibly infected at Malta and those probably infected in some other port. I have accordingly separated the cases which occurred between 6 days and 20 days after a ship's last visit to Malta, and placed them in a separate column headed "Cases connected with Malta." This admits a certain amount of error, because a ship may have visited other ports and become infected at them during the interval of 20 days. I have no record of the ports visited other than Malta. In a few cases no date was assigned for the onset of the fever, and these I have put in the column referred to, in proportion to the number of days in the year spent at Malta by the ship on which they occurred.

For the three years set out in the table the ships, as a whole, show an incidence of 28·55 per 1000 of strength constantly in Malta, a rate corresponding closely with that of the garrison in Malta during the same three years (28·08 per 1000). The two rates, however, are not really comparable, that of the Navy being calculated on a population

Table

Name of Ship.	1901. Complement.	1901. No. of days in Malta.	1901. No. of cases of Mediterranean Fever.	1901. No. of cases of Mediterranean Fever connected with Malta.	1901. Men. Days in Malta.	1902. Complement.	1902. No. of days in Malta.	1902. No. of cases of Mediterranean Fever.
H.M.S.—								
Renown	758	255	16	14	193,290	758	166	17
Ramillies	746	158	34	30	117,868	746	123	7
Cæsar	759	211	13	11	160,149	759	190	19
Illustrious	759	262	16	15	198,858	759	161	12
Victorious	759	133	14	10	100,947	759	170	6
Royal Oak	714	204	4	2	147,696	714	60	4
Royal Sovereign	714	254	19	18	180,356	714	97	8
Empress of India	714	104	9	8	74,256	—	—	—
Canopus	753	219	16	12	164,907	753	209	21
Theseus	546	173	10	8	57,158	546	67	12
Andromeda	679	209	8	5	141,911	679	142	6
Vindictive	429	183	1	0	78,507	429	162	6
Tyne	101	266	1	1	26,866	101	231	3
Hibernia	676	365	14	14	246,740	729	365	20
Devastation	410	156	1	0	63,960	410	5	0
Rupert	294	19	13	4	5,586	294	10	0
Diana	450	116	7	5	52,200	450	193	16
Hood	694	174	7	7	119,756	694	174	21
Harrier	122	124	0	0	15,128	124	55	0
Vulcan	443	138	5	3	61,134	443	230	8
Pegasus	226	95	3	2	21,470	226	117	4
Implacable	780	31	3	0	24,180	780	213	25
Gladiator	429	138	4	2	59,202	429	216	6
Scout	147	72	1	1	10,584	—	—	—
Pioneer	224	172	1	0	38,528	224	209	9
Barham	175	187	2	1	32,725	175	194	1
Pyramus	224	194	9	8	43,456	224	178	12
Surprise	107	255	9	9	27,285	107	258	4
Halcyon	122	16	0	0	1,952	—	—	—
Dryad	121	212	6	5	16,552	121	226	7
Hussar	121	154	0	0	18,634	121	176	1
Salamander	91	134	0	0	12,194	—	—	—
Speedy	91	192	3	3	17,472	91	246	6
Ardent	53	217	0	0	11,501	53	169	0
Dragon	53	262	0	0	13,886	53	146	0
Kangaroo	63	61	0	0	3,843	63	237	0
Desperate	63	27	0	0	1,701	63	276	0
Myrmidon	63	27	0	0	1,701	63	242	0
Chamois	63	56	0	0	3,528	63	276	0
Bruizer	53	227	0	0	12,031	53	140	0
Banshee	53	227	0	0	12,031	53	290	0
Foam	63	260	0	0	16,380	63	233	0
Earnest	63	274	0	0	17,262	63	260	0
Griffon	63	274	0	0	17,262	63	278	0
Boxer	53	246	0	0	13,038	53	97	0
Hardy	53	167	0	0	8,851	—	—	—

II.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
14	125,828	758	93	8	5	70,494	21·11	22·43	10·55
7	91,758	746	102	10	9	76,092	45·58	9·38	13·40
15	144,210	759	121	10	8	91,839	17·13	25·03	13·18
7	122,199	759	163	15	13	123,717	21·08	15·94	19·76
4	129,030	770	35	8	2	28,490	18·45	7·91	10·39
2	42,840	—	—	—	—	—	5·60	5·60	
5	69,258	—	—	—	—	—	26·61	11·20	
—	—	—	—	—	—	—	12·61		
16	157,377	753	8	5	2	6,024	21·25	27·90	6·64
12	36,682	—	—	—	—	—	18·32	23·96	23·96
4	96,418	—	—	—	—	—	11·78	8·83	
3	69,498	429	122	12	7	52,338	2·33	13·99	27·97
3	23,331	101	228	2	2	23,028	9·90	29·70	19·80
20	265,085	721	365	21	21	263,065	20·71	27·43	29·96
0	2,050	—	—	—	—	—	2·44	0·00	
0	2,940	—	—	—	—	—	44·22	0·00	
11	86,850	450	154	16	13	69,300	15·56	35·56	35·56
20	120,756	—	—	—	—	—	10·09	30·26	
0	6,820	124	86	0	0	10,664	0·00	0·00	0·00
8	101,890	443	96	4	2	41,528	11·29	18·04	9·03
2	26,442	226	196	3	3	44,296	13·28	17·70	13·28
22	166,140	780	199	23	12	155,220	3·85	32·05	29·49
5	92,664	429	160	5	2	68,640	9·32	13·99	11·66
—	—	149	5	0	0	745	6·80	—	0·00
6	46,816	224	99	3	2	22,176	4·46	40·18	13·39
1	33,950	—	—	—	—	—	11·42	5·71	
7	39,872	224	181	5	4	40,544	40·18	53·57	22·32
3	27,606	107	202	2	1	21,614	84·11	37·38	18·69
—	—	—	—	—	—	—	0·00		
6	27,346	121	171	16	13	20,691	49·59	57·85	132·23
1	21,296	123	139	0	0	17,097	0·00	8·26	0·00
—	—	—	—	—	—	—	0·00		
6	22,386	91	171	4	2	15,561	32·97	65·93	43·95
0	8,957	—	—	—	—	—	0·00	0·00	
0	7,738	—	—	—	—	—	0·00	0·00	
0	14,931	63	248	0	0	15,624	0·00	0·00	0·00
0	17,388	63	272	0	0	17,136	0·00	0·00	0·00
0	15,246	63	191	0	0	12,033	0·00	0·00	0·00
0	17,388	63	61	0	0	3,843	0·00	0·00	0·00
0	7,420	53	16	0	0	848	0·00	0·00	0·00
0	15,370	53	244	0	0	12,932	0·00	0·00	0·00
0	14,679	—	—	—	—	—	0·00	0·00	
0	16,380	63	164	0	0	10,332	0·00	0·00	0·00
0	17,514	63	208	0	0	13,104	0·00	0·00	0·00
0	5,141	53	80	0	0	4,240	0·00	0·00	0·00
—	—	—	—	—	—	—	0·00		

Table II

Name of Ship.	1901. Complement.	1901. No. of days in Malta.	1901. No. of cases of Mediterranean Fever.	1901. No. of cases of Mediterranean Fever connected with Malta.	1901. Men. Days in Malta.	1902. Complement.	1902. No. of days in Malta.	1902. No. of cases of Mediterranean Fever.
H.M.S.—								
Orwell	63	205	0	0	12,915	63	250	0
Coquette	63	253	0	0	15,939	63	242	0
Cygnet	63	186	0	0	11,718	63	242	0
Conflict	53	265	0	0	14,045	—	—	—
Cruiser	93	179	0	0	16,647	93	242	3
Imogene	42	75	0	0	3,150	53	91	0
Formidable	777	28	0	0	21,756	777	90	18
Pandora	226	10	0	0	2,260	226	174	0
Irresistible	—	—	—	—	—	780	145	5
Repulse	—	—	—	—	—	721	117	12
Flying Fish	—	—	—	—	—	63	175	0
Goldfinch	—	—	—	—	—	94	56	0
Bulwark	—	—	—	—	—	829	104	5
Vengeance	—	—	—	—	—	762	84	10
Aboukir	—	—	—	—	—	755	79	12
London	—	—	—	—	—	742	104	3
Hermione	318	12	0	0	3,816	324	141	11
Ariel	63	28	0	0	1,764	63	242	0
Naiad	—	—	—	—	—	276	76	3
*Orion	—	—	—	—	—	55	274	6
Panther	—	—	—	—	—	63	250	0
Locust	—	—	—	—	—	63	250	0
Thrasher	—	—	—	—	—	63	299	0
St. George	560	5	0	0	2,800	560	13	0
Juno	456	5	0	0	2,280	456	13	0
Rainbow	—	—	—	—	—	276	13	0
Brilliant	—	—	—	—	—	279	13	0
Albatross	—	—	—	—	—	69	137	0
Fawn	—	—	—	—	—	63	137	0
Mallard	—	—	—	—	—	63	123	0
Cynthia	—	—	—	—	—	63	126	0
Stag	—	—	—	—	—	63	14	0
Bat	—	—	—	—	—	63	14	0
Seal	—	—	—	—	—	63	14	0
Crane	—	—	—	—	—	63	14	0
Venerable	—	—	—	—	—	771	10	0
Bacchante	—	—	—	—	—	729	11	0
Intrepid	—	—	—	—	—	271	2	0
Mohawk	178	1	0	0	178	—	—	—
Russell	—	—	—	—	—	—	—	—
Montagu	—	—	—	—	—	—	—	—
Exmouth	—	—	—	—	—	—	—	—
Albemarle	—	—	—	—	—	—	—	—

* Since this table was made out, I have been informed that the cases returned as occurring on
thus refer to a total complement of 1331 men. This accounts for the apparent absence of cases

—continued.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
0	15,750	63	25	0	0	1,575	0·00	0·00	0·00
0	15,246	63	15	0	0	945	0·00	0·00	0·00
0	15,246	63	191	0	0	12,033	0·00	0·00	0·00
—	—	—	—	—	—	—	0·00		
3	22,506	93	89	1	1	8,277	0·00	32·28	10·75
0	4,823	41	59	0	0	2,419	0·00	0·00	0·00
10	69,930	777	183	18	12	142,191	0·00	23·17	23·17
0	39,224	226	115	1	1	25,990	0·00	0·00	4·45
3	113,100	780	125	14	8	97,500	—	6·41	17·95
6	84,357	721	74	4	1	53,354	—	16·64	5·55
0	11,025	63	263	0	0	16,569	—	0·00	0·00
0	5,264	—	—	—	—	—	—	0·00	
3	86,216	829	187	10	9	155,023	—	4·02	12·06
3	64,008	762	136	10	10	103,632	—	13·12	13·12
9	59,645	755	131	16	11	98,905	—	15·89	21·19
2	77,168	742	143	29	17	106,106	—	4·04	39·08
9	45,684	324	73	7	4	23,652	0·00	33·92	21·60
0	15,246	63	275	0	0	17,325	0·00	0·00	0·00
2	20,976	271	82	2	2	22,222	—	10·87	7·38
6	15,070	55	365	18	18	20,075	—	109·09	327·27
0	15,750	63	112	0	0	7,056	—	0·00	0·00
0	15,750	63	208	0	0	13,104	—	0·00	0·00
0	18,837	63	208	0	0	13,104	—	0·00	0·00
0	7,280	—	—	—	—	—	0·00	0·00	
0	5,828	—	—	—	—	—	0·00	0·00	
0	3,588	—	—	—	—	—	—	0·00	
0	3,627	—	—	—	—	—	—	0·00	
0	9,453	69	208	0	0	14,352	—	0·00	0·00
0	8,631	63	221	0	0	13,923	—	0·00	0·00
0	7,749	63	235	0	0	14,805	—	0·00	0·00
0	7,938	63	216	0	0	13,608	—	0·00	0·00
0	882	63	230	0	0	14,490	—	0·00	0·00
0	882	63	235	0	0	14,805	—	0·00	0·00
0	882	63	208	0	0	13,104	—	0·00	0·00
0	882	63	203	0	0	12,789	—	0·00	0·00
0	7,710	771	161	11	10	124,131	—	0·00	14·27
0	8,019	729	164	9	5	119,556	—	0·00	12·34
0	542	271	73	3	1	19,783	—	0·00	11·07
—	—	180	69	3	3	12,420	0·00	—	16·67
—	—	715	107	5	2	76,505	—	—	6·99
—	—	715	59	3	3	42,185	—	—	4·20
—	—	715	24	2	0	17,160	—	—	2·80
—	—	742	14	0	0	10,388	—	—	0·00

board H.M.S. "Orion" include cases which occurred on the torpedo-boat destroyer flotilla, and on board the torpedo-boat destroyer flotilla.

Table II

Name of Ship.	1901.					1902.		
	Complement.	No. of Days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.
H.M.S.—								
Arethusa	—	—	—	—	—	—	—	—
Thetis	—	—	—	—	—	—	—	—
Hawke	—	—	—	—	—	161	10	0
Spartiate	—	—	—	—	—	—	—	—
Europa	—	—	—	—	—	—	—	—
Sirius	—	—	—	—	—	—	—	—
Victoria and Albert	—	—	—	—	—	—	—	—
Minerva	—	—	—	—	—	456	6	0
Venus	452	17	0	0	7,684	—	—	—
Assaye	—	—	—	—	—	—	—	—
Porpoise	178	2	0	0	356	—	—	—
Merlin	—	—	—	—	—	—	—	—
Pique	—	—	—	—	—	—	—	—
Cossack	—	—	—	—	—	—	—	—
Leviathan	—	—	—	—	—	—	—	—
Goliath	—	—	—	—	—	—	—	—
Scylla	—	—	—	—	—	—	—	—
Diadem	—	—	—	—	—	—	—	—
Psyche	—	—	—	—	—	—	—	—
Duncan	—	—	—	—	—	—	—	—
Centurion	606	3	0	0	1,818	—	—	—
Argonaut	—	—	—	—	—	—	—	—
Arrogant	—	—	—	—	—	—	—	—
Furious	—	—	—	—	—	442	6	0
Undaunted	494	1	0	0	494	—	—	—
Ringdove	76	1	0	0	76	—	—	—
Peacock	76	2	0	0	152	—	—	—
Magicienne	224	1	0	0	224	—	—	—
Racoon	182	1	0	0	182	—	—	—
Linnet	92	4	0	0	368	—	—	—
Pigeon	76	1	0	0	76	—	—	—
Bonaventure	318	1	0	0	318	—	—	—
Marathon	224	1	0	0	224	—	—	—
Dido	450	2	0	0	900	—	—	—
Isis	450	2	0	0	900	—	—	—
Cockatrice	78	1	0	0	78	78	1	0
Melita	125	2	0	0	250	—	—	—
Ocean	751	2	0	0	1,502	—	—	—
Ophir	324	2	0	0	648	—	—	—
Rambler	113	87	0	0	9,831	—	—	—
Blake	128	2	0	0	256	—	—	—
Blenheim	592	2	0	0	1,184	—	—	—
Phœbe	217	2	0	0	434	—	—	—
Perseus	224	1	0	0	224	—	—	—
Talbot	442	1	0	0	442	—	—	—
Lapwing	78	1	0	0	78	—	—	—

-*continued.*

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
—	—	314	2	0	0	628	—	—	0·00
—	—	271	9	0	0	2,439	—	—	0·00
0	1,610	161	7	0	0	1,127	—	0·00	0·00
—	—	132	6	0	0	792	—	—	0·00
—	—	150	3	0	0	350	—	—	0·00
—	—	275	2	0	0	550	—	—	0·00
—	—	356	5	0	0	1,780	—	—	0·00
0	2,736	456	4	0	0	1,824	—	0·00	0·00
—	—	436	4	0	0	1,744	0·00	—	0·00
—	—	96	6	0	0	576	—	—	0·00
—	—	180	1	0	0	180	0·00	—	0·00
—	—	113	3	0	0	330	—	—	0·00
—	—	276	3	0	0	828	—	—	0·00
—	—	180	3	0	0	540	—	—	0·00
—	—	868	2	0	0	1,736	—	—	0·00
—	—	760	2	0	0	1,520	—	—	0·00
—	—	269	1	0	0	269	—	—	0·00
—	—	690	1	0	0	690	—	—	0·00
—	—	219	1	0	0	219	—	—	0·00
—	—	715	19	0	0	13,585	—	—	0·00
—	—	600	5	0	0	3,000	0·00	—	0·00
—	—	697	3	0	0	2,091	—	—	0·00
—	—	430	35	0	0	15,050	—	—	0·00
0	2,652	430	5	0	0	2,150	—	0·00	0·00
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
0	78	—	—	—	—	—	0·00	0·00	
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		

Table II

Name of Ship.	1901. Complement.	1901. No. of days in Malta.	1901. No. of cases of Mediterranean Fever.	1901. No. of cases of Mediterranean Fever connected with Malta.	1901. Men. Days in Malta.	1902. Complement.	1902. No. of days in Malta.	1902. No. of cases of Mediterranean Fever.
H.M.S.—								
Eclipse	455	3	0	0	1,365	—	—	—
Cressy	754	1	0	0	754	—	—	—
Albion	791	4	0	0	3,164	—	—	—
Fox	324	3	0	0	972	—	—	—
Iphigenia	105	6	0	0	630	105	1	0
Fearless	149	1	0	0	149	—	—	—
Mutine	105	2	0	0	210	—	—	—
Vestal	105	1	0	0	105	—	—	—
Amphitrite	327	3	0	0	981	327	4	0
Rinaldo	—	—	—	—	—	105	2	0
Espiègle	—	—	—	—	—	113	3	0
Daphne	—	—	—	—	—	138	2	0
Brisk	—	—	—	—	—	180	10	0
Aurora	—	—	—	—	—	503	1	0
Redpole	—	—	—	—	—	78	1	0
Plover	—	—	—	—	—	78	3	0
Pigmy	—	—	—	—	—	78	1	0
Astræa	—	—	—	—	—	321	1	0
Orlando	—	—	—	—	—	503	2	0
Endymion	—	—	—	—	—	553	1	0
Terrible	—	—	—	—	—	870	2	0
Majestic	—	—	—	—	—	806	6	0
Magnificent	—	—	—	—	—	799	6	0
Hannibal	—	—	—	—	—	769	6	0
Prince George	—	—	—	—	—	766	6	0
Jupiter	—	—	—	—	—	769	6	0
Mars	—	—	—	—	—	766	6	0
Niobe	—	—	—	—	—	689	6	0
Sutlej	—	—	—	—	—	755	6	0
Doris	—	—	—	—	—	426	6	0
Pactolus	—	—	—	—	—	229	6	0
Prometheus	—	—	—	—	—	229	6	0

Summary of Table II.

Totals.	1901.	1902.	1903.
Number of cases of Mediterranean Fever	249	349	338
Number of cases of Mediterranean Fever connected with Malta	198	266	241
Men—days in Malta	2,810,819	3,319,849	2,882,323
Average men constantly in Malta	7,700·87	9,095·48	7,896·77
Cases per 1000 complement	25·71	29·25	30·51
3 years' average		28·55	

continued.

1902.		1903.					Cases per 1000 complement.		
No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	Complement.	No. of days in Malta.	No. of cases of Mediterranean Fever.	No. of cases of Mediterranean Fever connected with Malta.	Men. Days in Malta.	1901.	1902.	1903.
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
0	105	—	—	—	—	—	0·00	0·00	
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
—	—	—	—	—	—	—	0·00		
0	1,308	—	—	—	—	—	0·00	0·00	
0	210	—	—	—	—	—	—	0·00	
0	339	—	—	—	—	—	—	0·00	
0	276	—	—	—	—	—	—	0·00	
0	1,800	—	—	—	—	—	—	0·00	
0	503	—	—	—	—	—	—	0·00	
0	78	—	—	—	—	—	—	0·00	
0	234	—	—	—	—	—	—	0·00	
0	78	—	—	—	—	—	—	0·00	
0	321	—	—	—	—	—	—	0·00	
0	1,006	—	—	—	—	—	—	0·00	
0	553	—	—	—	—	—	—	0·00	
0	1,740	—	—	—	—	—	—	0·00	
0	4,836	—	—	—	—	—	—	0·00	
0	4,794	—	—	—	—	—	—	0·00	
0	4,614	—	—	—	—	—	—	0·00	
0	4,596	—	—	—	—	—	—	0·00	
0	4,614	—	—	—	—	—	—	0·00	
0	4,596	—	—	—	—	—	—	0·00	
0	4,134	—	—	—	—	—	—	0·00	
0	4,530	—	—	—	—	—	—	0·00	
0	2,556	—	—	—	—	—	—	0·00	
0	1,374	—	—	—	—	—	—	0·00	
0	1,374	—	—	—	—	—	—	0·00	

often absent from Malta during the season when Mediterranean Fever is at its worst.

It appears that when Mediterranean Fever attacks the crew of a ship one year, it is very likely to attack the crew of the same ship in each of the following years that she remains on the station.* There is little relation between the number of days spent by a ship in Malta and the number of cases of Mediterranean Fever which occur

* H.M.S. "Rupert" left the Mediterranean in February, 1902.

on board her, but since no allowance is made in the table for the time of year at which the ship was in Malta, the relation may be closer or less close than is apparent here.

The facts seem to point to the ship herself becoming infected, and in some way assisting in the transmission of infection. Of course, the larger the crew the greater the chance of infection being introduced into the ship from outside. It must be remembered, however, that I am only dealing with a three-year period, which is altogether too short to base reliable conclusions upon.

The data from which the above table is compiled did not reach me until some time after I left Malta, so that I was unable to make investigation by its light on board ships which were at Malta during my visit. It may be said, however, that on larger ships the ventilation is better, and that on Destroyers, in particular, the closets are so constructed that they must be very difficult to cleanse.

The distribution of Mediterranean Fever amongst the garrison during the period 1897 to 1903 is shown in the following table, which

Table III.

	Number of cases of Mediterranean Fever admitted to hospital during the period 1897—1903.	Average number of men in occupation during each year of the period 1897—1903.	Average number of cases admitted per 1000 of strength per year during the period 1897—1903.
St. Francis, Floriana (R.E.) and Ravelin	20	194·86	14·7
Floriana (infantry)	249	572·14	62·2
Lower St. Elmo (infantry)	134	649·57	29·4
Upper ,, (R.G.A)	46	272·86	24·0
Tigne (R.G.A.)	54	412·57	18·7
Manoel (infantry), including huts	133	832·86	22·8
Notre Dame (infantry), including Ravelin and huts	49	217·14	32·2
Old laboratory (infantry and A.S.C.)	17	86·43	28·1
Marsamuscetto (infantry and A.O.C.)	18	74·43	34·5
St. James' Cavalier (R.G.A.)	12	129·86	13·2
Verdala (infantry)	104	534·14	27·8
Imtarfa (infantry and various)	224	989·29	13·7
Porte de Bombe tents	1	No record	available.
Castille (R.A. and R.E.)	1	17·86	8·0
Fort Madelina (R.G.A.)	1	25·71	5·6
Valetta Hospital (R.A.M.C.)	29	65·00	65·2
Mellieha Camp	33	273·40*	24·1*
Corradino Prison	6	16·00	53·6

* For period 1899—1903, not occupied before 1899.

Table III—*continued.*

	Number of cases of Mediterranean Fever admitted to hospital during the period 1897—1903.	Average number of men in occupation during each year of the period 1897—1903.	Average number of cases admitted per 1000 of strength per year during the period 1897—1903.
Camarata married quarters	15	82·86	25·9
Sliema married quarters............	7	No record	available.
St. Clements (infantry)............	5	50·00	14·3
Zabbar Gate ,, ...	10	93·86	15·2
Zeitun Gate ,, ...	4	55·43	10·3
Polverista ,, ...	35	156·86	31·9
St. Nicholas ,, ...	4	33·71	16·9
Vittoriosa ,, ...	3	47·43	9·0
Salvatore ,, (including C. Guard)......................	2	96·43	2·1
Fort St. Angelo (R.M.A. and infantry)	2	83·71	3·4
Couvre Porte (infantry and R.M.A.)	1	51·43	2·8
Inquisitor's Palace (infantry).......	3	7·29	58·8
St. Paul's Bastion (infantry and A.S.C. stables)..................	4	26·29	21·7
St. John's Bastion (infantry)........	1	22·43	6·4
Fort Ricasoli (R.G.A.)	40	495·14	11·5
,, Rinella ,, ...	1	15·86	9·0
,, Delimara ,, ...	6	23·43	36·6
,, San Leonardo (R.A. and R.E.)	3	25·14	17·0
,, della Grazia (R.G.A.)	2	13·00	22·0
,, San Francesco (infantry)......	2	23·71	12·0
,, Isola Gate (infantry)..........	8	39·14	29·2
Cottonera Hospital (R.A.M.C.)......	25	44·14	80·9
Pembroke (R.G.A. and infantry)....	49	187·14	37·4
Duerra Lines (R.G.A.)..............	1	4·57	31·9
Ghain Tuffieha....................	99	370·67*	89·0*
St. George's Barracks (R.G.A. and infantry)	108	1024·71	15·1
Forrest Hospital (R.A.M.C.)........	1	9·43	15·1
Gozo	24	199·86	17·2
Fort Lascaris (R.M.A.)	29	253·86	16·3
Living in places not mentioned above	0	443·29	00·0
Whole garrison	1625	9037·43	25·6

is compiled from information furnished me by the Director of Transport and Supplies, and by the Principal Medical Officer in Malta. The cases are only those admitted to hospital, and would include all cases occurring amongst the garrison except a few officers who were nursed at their own homes. Of these I could not obtain a record.

The average annual attack rate for the whole garrison, as far as

* For years 1901, 1902, and 1903, not occupied before 1901.

TABLE IV.

Age	1902.					1903.					1902 and 1903.
	Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Ratio per 1000 of strength per year.
				Admissions.	Deaths.				Admissions.	Deaths.	Admissions.
Under 20 years......	1032	14	0	13·6	0·00	1041	67	3	64·4	2·88	39·8
From 20 to 25 years..	2939	45	1	15·3	0·34	3460	196	1	56·6	0·29	37·7
" 25 30 " ..	1926	18	1	9·3	0·52	1495	53	1	35·4	0·67	20·8
" 30 35 " ..	1498	24	3	16·0	2·00	1117	34	2	30·4	1·79	22·2
" 35 40 " ..	1593	39	0	24·5	0·00	1294	37	1	28·5	0·77	26·3
40 years and upwards.	230	15	1	65·2	4·35	386	17	1	44·0	2·59	57·9
Totals.........	9218	155	6	16·8	0·65	8793	404	9	45·9	1·02	31·0

this record goes, was 25·6 per 1000 during the seven-year period 1897 to 1903. The heaviest incidence was upon Floriana Infantry Barracks, Valetta Station Hospital, Cottonera Hospital, and Ghain Tuffieha Camp. The two* first places are specially dealt with subsequently; the heavy incidence upon Ghain Tuffieha Camp was occasioned by an outbreak in 1903. A large number of men annually occupy the camp for a few months during the summer only, so that an outbreak occurring amongst them raises the figure representing the annual case incidence out of proportion to the importance of the outbreak itself, because the representative figure is calculated on the average occupation during the whole year.

Age and Sex Incidence could not be ascertained from the civil official returns, but next autumn figures which are now being collected for the year ending July 31, 1905, will be available.

The age incidence for the garrison during 1902 and 1903 is shown as far as possible in Table IV (see page 32).

The two years tabulated show considerable disparity in the number of admissions and in the resulting ratios per 1000 of strength. From the figures of the two years together, it would appear that men under 25 years of age suffer more than the average number of attacks per 1000. From 25 to 40 there is a degree of immunity becoming less with advancing years. Over age 40 the incidence again becomes severe. The deaths are too few to permit of any useful deductions being made from them.

Length of Service in Malta is, as might be expected, closely connected with age in its influence upon the incidence of Mediterranean Fever, as the following table shows (see page 34).

The heaviest incidence of Mediterranean Fever is upon men with less than one year's service; in fact, they are the only class shown with an incidence greater than the average incidence of the disease upon all classes taken together. The incidence upon men with over two years' service is less than half that upon men with under two years' service, and the severity of incidence continues to decrease with length of service up to five years, after which it again rises. In the last three classes shown in the table, however, the numbers dealt with are too small to carry much weight.

The decrease of incidence with length of service in Malta is, no doubt, influenced to a large extent by the elimination of the more susceptible subjects. Further figures will be available next autumn.

The Case Mortality amongst the civil population differs enormously in different localities, as is to be expected when dealing with small numbers and unreliable notification returns. Amongst the civil population of Malta, 8·9 cases per 100 attacked died during the period

* There was an outbreak of Mediterranean Fever in Floriana infantry barracks during 1903. The details were not obtained in time for inclusion in this report.

TABLE V.

Length of service in Malta.	1902.					1903.					1902 and 1903.
	Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Average strength.	Admissions to hospital on account of Mediterranean Fever.	Deaths from Mediterranean Fever.	Ratio per 1000 of strength per year.		Ratio per 1000 of strength per year.
				Admissions.	Deaths.				Admissions.	Deaths.	Admissions.
Under 1 year........	4878	103	3	21 ·1	0 ·62	4543	261	2	57 ·5	0 ·44	38 ·6
From 1 to 2 years....	1913	30	1	15 ·7	0 ·52	3142	117	5	37 ·2	1 ·59	29 ·1
,, 2 3 ,, ...	1190	10	0	8 ·4	0 ·00	550	16	2	29 ·1	3 ·64	14 ·9
,, 3 4 ,, ...	550	6	1	10 ·9	1 ·82	259	6	0	23 ·2	0 ·00	14 ·8
,, 4 5 ,, ...	309	3	0	9 ·7	0 ·00	173	0	0	00 ·0	0 ·00	6 ·2
,, 5 10 ,, ...	292	2	1	6 ·8	3 ·42	106	4	0	37 ·7	0 ·00	15 ·1
10 years and upwards.	86	1	0	11 ·6	0 ·00	20	0	0	00 ·0	0 ·00	9 ·4
Totals	9218	155	6	16 ·8	0 ·65	8793	404	9	45 ·9	1 ·02	31 ·0

1894 to 1903, and amongst the civil population in Gozo, 8·4 per 100 attacked died during the same period. These figures form a striking contrast to the case mortality of the Army and of the Navy. In the Army, during the period 1897 to 1903, the case mortality was 3·2 per cent., and in the Navy it was only 1·4 per cent. during the period 1897 to 1901. It is probable that the case mortality is higher amongst the civil population than in the Army and Navy, owing to the superior nursing and attention enjoyed by the services, but I do not think it likely that the difference noted above represents the true state of affairs. Probably the high case mortality among the civilians is largely due to the fact that mild cases of Mediterranean Fever more often escape notification than severe ones.

Temperature and Rainfall in Connection with Mediterranean Fever.—No official data were available with regard to temperature and rainfall for the whole of the period 1894 to 1903. The curves in the accompanying chart are constructed from figures kindly supplied me by the Rev. Father J. F. Dobson, S.J., the result of observations made at St. Julian's, near Valetta. I have inserted also a curve representing the case incidence of Mediterranean Fever, for comparison. The last-named curve is based on figures taken from the civil official notification records (see next page).

It will be at once seen that there is a very close correspondence between the curve representing the temperature and that representing the number of cases. The rise of the latter curve follows that of the former at an interval of about one month, which would be approximately sufficient to allow for incubation and notification if the incidence of fever were directly dependent upon the temperature of the air. The temperature curve attains its maximum in July and continues high during August, after which it begins to drop. The case curve attains its maximum a month later, but, unlike the temperature curve, it at once commences to drop, so that it would appear that whatever connection the air temperature may have with case incidence, does not remain so obvious after the former has attained its maximum.

The curve representing rainfall is in general the inverse of that representing temperature. It attains its minimum in July, but it is almost as low in June and August. The "case" curve commences to drop at the same time that the rainfall curve commences to rise, allowing no interval for incubation and notification, so that the connection is not clear; nor does the steep rise of the rainfall curve, at the end of September, produce a correspondingly steep decline in the case curve as might have been expected were the connection between the two intimate.

Seasonal Prevalence of Mediterranean Fever.—On p. 37 will be found a table giving the number of cases that were notified each month of

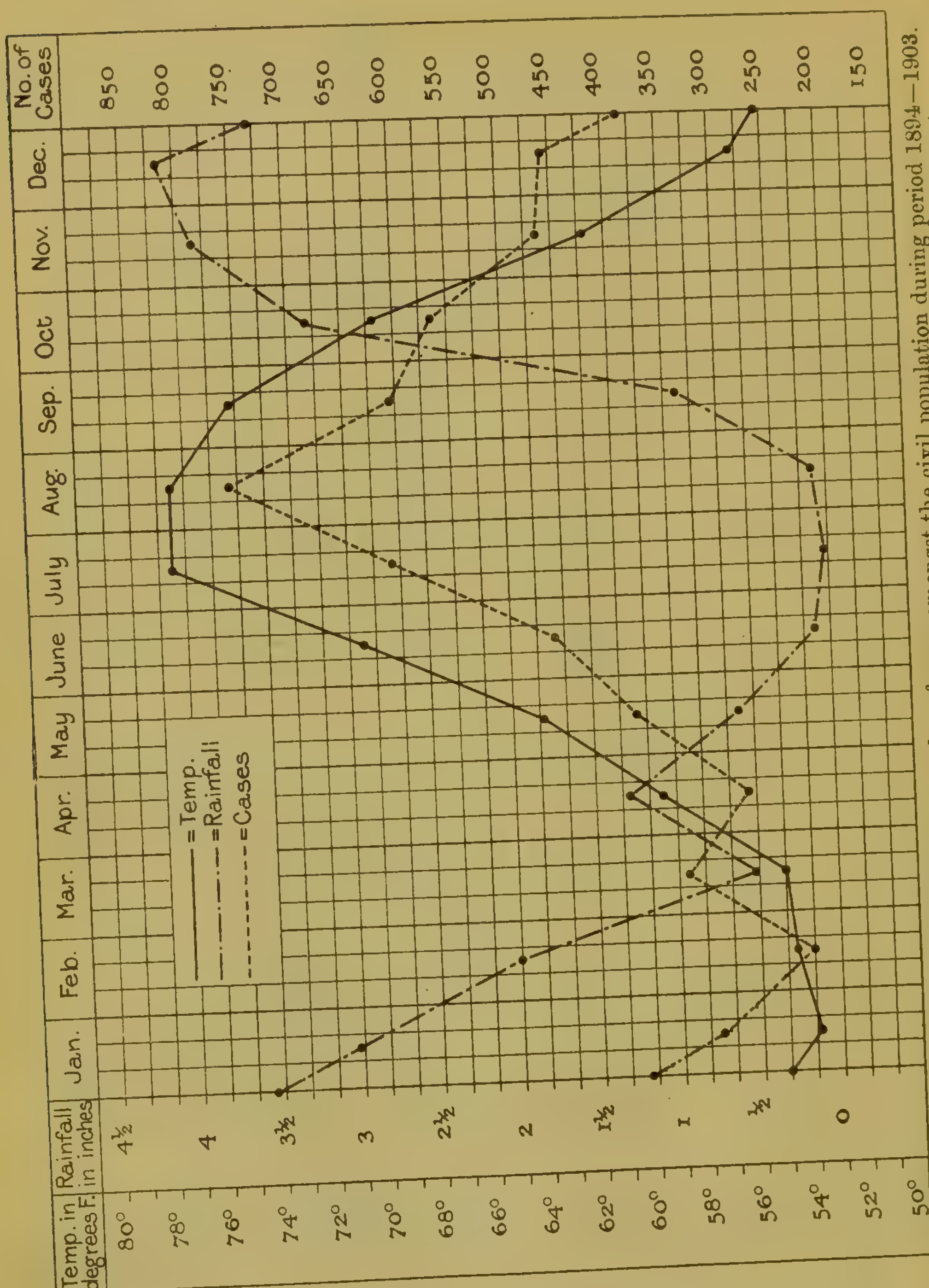

Chart showing temperature, rainfall, and number of cases amongst the civil population during period 1894–1903.

each year of the period 1894 to 1903, together with the total number of cases which were notified during the period in each month.

The figures in Table VI probably represent with some accuracy the seasonal prevalence of Mediterranean Fever, because though they are founded upon the civil official notification returns, there does not appear to be any particular reason why these returns should be more inaccurate at one time of the year than at another.

Table VI.

	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1894	22	6	35	28	24	18	44	22	53	30	16	21
1895	10	9	21	23	11	26	16	47	42	18	27	12
1896	18	11	16	27	70	69	126	145	71	33	31	30
1897	28	25	22	30	52	50	92	89	49	47	41	38
1898	41	16	17	20	36	32	49	40	50	64	54	88
1899	61	33	49	39	47	63	105	77	58	103	91	71
1900	38	30	37	33	37	42	65	83	79	78	82	44
1901	46	32	25	24	41	67	74	89	78	64	43	42
1902	17	34	37	34	33	37	66	84	71	61	49	65
1903	32	26	31	23	35	54	68	82	54	71	33	44
Total	313	222	290	281	386	458	605	758	605	569	467	455

The maximum prevalence would appear to be in the month of August and the minimum in February. It is to be noted that the number of cases notified during February does not approach zero, being roughly 30 per cent. of the number notified in August.

From February to August there is each month a steady increase in the number of cases, except for a slight drop-back in April, and from August to February a steady decrease.

Consideration of Ways in which the Infection of Mediterranean Fever may be Transmitted.

(1) *Direct Personal Infection* (that is, by contact, or by the breath, or by the saliva).—No reliable data as to the number of dwellings in which more than one case of Mediterranean Fever occurred, could be obtained from the official notification records. The name of the patient was seldom given, and on visiting an address which had appeared more than once in the records, it was generally found to be a tenement house occupied by 15 or 20 families. Often there was no record of the number of the house, the street only being indicated.

Amongst 100 houses which I personally visited, in all of which Mediterranean Fever had been notified during 1904, I only found six houses in which there had been more than one case notified. There was often strong probability that other cases of a lighter nature than that notified had occurred, but the information elicited was never conclusive.

In Malta, outside Valetta, Cospicua, Vittoriosa, and Senglea, as noted above, both density of population upon area, and aggregation of a large number of persons in one locality appear to favour the spread of Mediterranean Fever. This may be because such conditions give greater opportunity for close personal contact, and so for direct personal infection. In making any inference it must not be forgotten

that Valetta and the three cities are exceptions, although both conditions are present in an eminent degree. It would appear, therefore, that whatever may be the conditions which favourably differentiate Valetta and the three cities from the rest of Malta, they must have an enhanced importance in their bearing upon the spread of Mediterranean Fever, inasmuch as they seem to more than counterbalance two conditions which appear to favour the spread of the disease in other parts of Malta.

Thirty-five women, wives of non-commissioned officers in the garrison, were attacked by Mediterranean Fever during 1904. Only two of them were removed to hospital. If direct personal infection were always an important factor in the spread of Mediterranean Fever, it would be expected that a large proportion of the husbands of these women would have been attacked, yet only five fell ill. Moreover, in two cases out of the five the husband and wife appear to have fallen ill on the same day, which would point rather to infection from a common source, than to infection from husband to wife, or *vice versâ*.

Set out in the following table is a comparison between the three principal hospitals of Malta, showing separately the incidence of Mediterranean Fever upon the nursing staffs, and upon the patients undergoing treatment in hospital for other diseases, during the five years 1899 to 1903 respectively. I have added to the table, for comparison, the incidence of Mediterranean Fever upon the troops quartered in Valetta during the same period.

The number of patients per 1000 constantly ill, in other words, per mean yearly number of patients in hospital, is not strictly comparable with that of the staff per 1000 of strength, because in the former we are dealing with a shifting population in which fresh patients would constantly become exposed to infection, if the hospital were a centre of infection, whereas the staff would not vary in the same degree. In addition, the patients in hospital would be more numerous in summer, owing to "simple continued fever," than in winter.

It will be seen that during the period the average incidence of Mediterranean Fever upon patients treated in the Station Hospital, Valetta, was less than that upon the troops quartered in Valetta, while in the other two hospitals it was much greater. In all three hospitals very severe incidence occurred on the nursing staffs.

For the better consideration of the difference of incidence upon the respective staffs of the three hospitals I add here a short note upon each.

The Station Hospital, Valetta, has only attempted to isolate Mediterranean Fever since 1903. The isolation is incomplete; the Mediterranean Fever wards are separated from other wards only by a wall reaching about half-way to the ceiling. Enteric cases are frequently put in the Mediterranean Fever wards, and I have seen at least one case of Mediterranean Fever in a general ward.

Table VII.

	Valetta Station Hospital.			Central Civil Hospital.			R.N. Hospital, Bighi.			Valetta troops.
	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst hospital orderlies per 1000 of strength.	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst hospital nursing staff per 1000 of strength.	No. of cases of Mediterranean Fever admitted.	No. of cases of Mediterranean Fever which occurred amongst hospital patients per 1000 constantly ill.*	No. of cases of Mediterranean Fever which occurred amongst sick bay staff per 1000 of strength.	No. of cases of Mediterranean Fever per 1000 of strength.
1899..	84	32 ·00	34 ·48	129	58 ·44	171 ·4	111	66 ·67	83 ·3	22 ·54
1900..	85	6 ·44	54 ·03	147	100 ·63	171 ·4	261	89 ·55	459 ·5	26 ·18
1901..	127	45 ·75	121 ·21	127	96 ·15	138 ·9	175	78 ·43	122 ·0	43 ·11
1902..	60	34 ·18	48 ·78	127	47 ·62	111 ·1	272	175 ·50	476 ·2	16 ·90
1903..	222	12 ·26	50 ·00	154	83 ·80	83 ·2	279	102 ·74	150 ·3	17 ·31
		25 ·9	56 ·5	—	77 ·2	134 ·8	—	105 ·18	289 ·34	34 ·31

* The number of cases which occurred amongst hospital patients was calculated for each hospital by reckoning all cases of Mediterranean Fever which occurred in patients more than 14 days after their admission, and less than 14 days after their discharge. Patients who were admitted suffering from a disease that might have been Mediterranean Fever are excluded.

The means provided for the disposal of bed-pan contents and slops are wholly inadequate. A separate slop sink is used for enteric and Mediterranean Fever cases only. It is, however, on a different landing to the wards, and at a considerable distance. It is not supplied with a proper flush for cleansing purposes, and it is in a small dark room with faulty pavement. Some bed-pans examined by me were found to be very foul, though supposed to be cleansed. Izal is used for disinfecting the bed-pans, and carbolic solution for the orderlies' hands. The patients are cleansed with carbolic solution after the bed-pan has been used, and izal is put in the bed-pan before use.

Water-closets are used by enteric and Mediterranean Fever convalescents in common with other convalescents. The urinal provided is of the perpendicular slab type with an insufficient flush. It smelt offensively and the floor was soiled with urine.

The hospital orderlies spend about 50 hours per week in the wards.

The Royal Naval Hospital, Bighi, has isolated Mediterranean Fever for the past three years in special wards. These wards are amply provided with modern hospital sinks containing powerful flushes. Three of the sinks in the hospital were not ready for immediate use at the time of my visit. Izal is placed in the bed-pan before use, and an india-rubber sheet is put under the patient. The sheet shown me was perished and soiled. The patient is cleaned with soap and water, but the attendant does not disinfect his hands as a routine matter.

The sick-bay staff spend between 66 and 71 hours in the wards per week. Soiled linen is conveyed to the laundry by the sick-bay staff and washed with the other linen.

The Central Civil Hospital.—No attempt is made here to isolate patients suffering from Mediterranean Fever. They are distributed at haphazard throughout the medical wards.

Bed-pans are emptied into a gully in an open space between the wards. The edges of the gully are protected by a metal funnel, but the bed-pans are carried carelessly across the open space, dripping portions of their contents on the pavement, and are roughly washed out at a hot-water tap over an ordinary grating.

The attendant does not cleanse his hands after the operation, and the bed-pan is not usually disinfected, though occasionally a small portion of "carbolic" powder is dusted into it. No attempt was made to cleanse the patient at the time of my visit, and his person and bed proved upon inspection to be in a filthy condition.

Infected clothing is said to be steeped in tubs containing a 1 in 1000 solution of corrosive sublimate before removal to the laundry at the poor-house. At the time of my visit there was no infected clothing in the two small tubs shown me, and I was informed that the liquid they contained was not corrosive sublimate solution.

The nurses spend practically all their time in the wards, eating

and sleeping there; but they have a holiday every third day from midday until 6 the next morning, or if it happen to be a visiting day (Wednesday or Sunday), they leave at 4 P.M. instead of midday. In addition, they have a holiday every three weeks from 9 A.M. to 6 A.M. the following day.

Male ward cleaners have the same hours except that they leave hospital on alternate days at 5 P.M., returning at 6 A.M., and on alternate Sundays from 8 A.M. to 6 A.M. on Monday.

Briefly, the Military Station Hospital has practised partial isolation during 1903.

The Royal Naval Hospital has practised complete isolation during the past three years.

The Central Civil Hospital has made no attempt at isolation.

The Military Hospital and the Naval Hospital take precautions against the spread of infection by excreta; while in the Civil Hospital such precautions are almost altogether neglected.

The incidence upon the staffs of the three hospitals is not in proportion to the precautions taken against infection, nor to the number of hours spent in the wards.

The patients and attendants in the civil hospital are entirely Maltese, and if the incidence upon either the one or the other be compared with the incidence upon the civil population of Malta as a whole, the result is remarkable. The attendants show an incidence of 134·8 per 1000, the patients 77·2 per 1000 constantly ill, while the civil population of Malta shows only 3·2 per 1000 during the 10 years, 1894 to 1903. These results are no doubt due largely to faulty notification.

It is possible that so-called endemic acquired immunity may play a part in reducing the incidence on the patients and attendants in the civil hospital, and that such immunity may invalidate comparisons with hospitals occupied altogether by Englishmen.

If the Valetta Station Hospital be compared with the Naval Hospital it will be found that the incidence of Mediterranean Fever upon the respective staffs and patients is not in proportion to the amount of isolation attempted, but is more or less in proportion to the amount of care exercised in disposing of the excreta of patients, and the number of hours spent in the wards by the attendants.

The cause of special incidence of Mediterranean Fever in the hospitals does not, on the evidence obtained, appear to be direct personal infection, since that would probably be more evident in the hospital where least isolation is attempted. The incidence, mentioned above, on non-commissioned officers whose wives suffered from Mediterranean Fever points in the same direction. Neither is the evidence in favour of a place infection, to which the patients would probably be more exposed

than the staff, and would, in addition, constantly present fresh material.

It is possible that an aggregation of cases of Mediterranean Fever in one place may be more infective than the same number spread over a large area, but we have no evidence to point to this. In the Naval Hospital during 1904—a very short period, no doubt—only one case of Mediterranean Fever arose amongst the patients occupying the adjoining wards to the Mediterranean Fever wards. A table showing the cases of Mediterranean Fever which occurred amongst patients in the Naval Hospital during 1904 will be found on p. 49.

(2) *Excretal infection* may occur by means of infected dust inhaled or swallowed, by contamination of the hands, and thence the mouth, or by contamination of food or drink.

Dust is very prevalent out of doors in Malta, because of the friable nature of the rock and the hot sun, and owing to the high winds prevalent, opportunity of inhaling or swallowing it is present during the greater part of the year. There is, without doubt, possibility of frequent pollution of the dust by the excreta of mild or unrecognised cases, more especially in the suburban area, where conveniences are few and scavenging desultory. Horrocks has shown that the *Micrococcus melitensis* is found in the urine of Mediterranean Fever patients, and that it can live for long periods in a desiccated condition.

The seasonal curves of temperature and rainfall are such that the degree of dust prevalence corresponds closely with the degree of Mediterranean Fever prevalence. It is true that the Mediterranean Fever curve begins to fall immediately after attaining its maximum, while the curve of temperature remains high and the curve of rainfall low; but that may be accounted for by the fact that the "Sciroc" wind begins to blow in August. I am informed that this wind is so laden with moisture that it renders the roads damp during its prevalence in August and September. I cannot say I observed this phenomenon during my stay in Malta, but during the summer of 1904 there was very little "Sciroc," although the temperature was unusually high.

The rainfall curve is on the whole consistent with the theory of dust infection, being in general the inverse of the Mediterranean Fever curve; but I understand that during long periods in the rainy season there is little or no dust. If this be so, and dust be largely concerned in the spread of infection, it would be expected that there would be corresponding periods almost free from Mediterranean Fever notifications, which is not the case.

I have made out the following table with a view to comparing the incidence during the most dusty months of the period 1894 to 1903 with that during the least dusty months, for the three areas, urban, suburban, and rural.

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Urban area—												
Valetta	19	14	30	12	20	23	63	40	37	20	33	29
Floriana	15	5	16	16	14	36	33	40	29	26	23	17
Cospicua	8	8	4	7	8	45	38	28	16	21	10	8
Vittoriosa	8	7	6	3	7	20	15	23	28	21	12	14
Senglea	5	1	3	3	7	9	8	11	17	7	5	8
	55	35	59	41	56	133	157	142	127	95	83	76
Suburban area—												
Misida and Pietá	14	10	6	6	7	16	35	41	24	20	15	14
Sliema and St. Julian's	25	15	22	26	28	36	75	58	63	53	21	48
Hamrun	30	26	35	38	43	46	63	117	63	69	44	33
Birchirchara	37	29	26	27	25	34	66	45	48	45	32	27
Curmi	1	4	3	2	2	3	6	12	3	5	6	1
Tarxien and Paola	5	6	5	7	11	10	9	10	6	10	13	9
Zabbar	19	10	23	7	18	14	22	25	19	22	18	17
	131	100	120	113	134	159	276	308	226	224	149	149
Rural area—												
Notabile and Rabato	15	10	7	18	14	18	40	24	21	33	13	30
Dingli	1	2	—	2	1	2	2	6	8	5	—	1
Zebbug	16	12	15	16	25	12	28	46	37	31	30	22
Siggeui	3	3	6	3	5	5	14	12	11	8	5	11
Lia, Attard, and Balzan	10	3	12	28	37	19	49	50	37	42	24	19
Naxaro	6	6	4	1	7	8	9	13	17	14	15	9
Musta	20	4	5	9	4	11	11	18	19	34	44	12
Gargur	—	—	1	—	—	2	2	5	6	5	8	2
Mellieha	1	1	—	1	1	2	—	4	2	6	6	2
Luca	—	—	1	4	1	2	2	2	3	2	4	5
Zurrico	10	4	2	1	3	5	12	6	14	12	5	13
Krendi	—	—	1	2	4	1	4	6	3	2	2	6
Safi	1	3	—	—	1	1	1	2	—	1	1	—
Micabiba	1	1	—	—	1	—	2	5	3	3	2	5
Chircop	—	1	—	—	1	1	2	3	2	2	—	2
Zeitun	13	10	13	13	24	10	32	31	26	9	25	16
Axiak	4	1	1	1	1	4	3	3	8	1	3	3
Gudia	3	—	2	1	1	4	8	4	2	2	1	2
	104	61	70	100	131	107	221	240	219	212	188	160

I take March to September inclusive as being the driest and consequently the most dusty months; and January, February, October, November, and December as the wettest and least dusty months. Allowing a month for incubation and notification, we have April to October representing the dry part of the year and the remaining months the wet.

In the urban area the average number of cases in the dry season was 10·73 per month, and in the wet season 6·16; that is in the proportion of 100 to 56.

In like manner in the suburban area the average number of cases per month in the dry season bears to the average number of cases per month in the wet season the proportion of 100 to 63, while a similar comparison in the rural area gives a proportion of 100 to 66.

	Proportion of cases per month in the wet season to the cases per month in the dry season.
Urban area	100 to 56
Suburban area	100 „ 63
Rural area	100 „ 66

This is not the result to be expected had contaminated dust contributed largely to the spread of Mediterranean Fever. There is less dust in the urban area, and less opportunity for dust contamination, on account of superior paving, draining, and scavenging, and also because all the urban area abuts upon the sea, much of it being built on tongues of land almost surrounded by water. It would be expected that the difference between the prevalence of Mediterranean Fever in the dusty season and in the wet season would prove least marked in the urban area, but, on the contrary, the difference is most marked in this area. These figures, taken for what they are worth, do not indicate that contaminated dust in the open air has a marked influence upon the incidence of Mediterranean Fever.

In the consideration of excretal infection by way of the hands or by way of food, special incidence upon certain hospital nurses and orderlies who have the handling and cleansing of Mediterranean Fever patients has already been noticed under the heading "Direct Personal Infection."

Abundant opportunity for soiling the hands and for pollution of the food is afforded by the methods of excreta disposal in use in the islands, which have already been referred to in Part I of this report. Amongst 100 houses examined in which Mediterranean Fever had occurred during 1904, I found that 75 had faults of one kind or another which rendered pollution of the hands, or of food, with excretal matter, probable. Amongst 40 other houses not infected with

Mediterranean Fever during 1904, but examined by way of control, I found 55 per cent. suffering from faults of a like kind. The control houses were selected by reason of their similarity to the infected houses; they were very often next door, and they were always of the same class and in the same neighbourhood as the infected houses. Large figures, however, extending over several years, would be required to give value to such data as these. Such as it is, however, the evidence is in favour of the probability of excretal pollution of the hands or food, or of dust inside houses having played a part in the spread of infection. As against this probability there is the fact that amongst the civil population, where opportunity for this kind of infection is far greater than amongst the garrison or Navy, the case incidence of Mediterranean Fever is in general about one-eighth as severe. Here, however, the notification returns are probably at fault.

(3) *Newly-turned earth* has been suspected by more than one observer to be a cause of outbreaks of Mediterranean Fever. When the porous nature of the rock in Malta is considered together with the fact that sewage has been allowed to percolate into it, and into the soil above it, for centuries, it does not seem remarkable that digging operations should have been suspected.

Mr. Cartwright-Read, the Admiralty Superintendent of Works, kindly undertook to furnish me with immediate notice of cases of sickness arising amongst the men employed by him on digging operations in Fort St. Angelo during my stay in Malta. In July 255 men were employed, in August 327, and in September 337. All men absent from work on account of illness during these three months were visited and reported upon, and no case of Mediterranean Fever was discovered. The ground opened up was probably at one time very much fouled, part of it having been the ancient prison of the galley slaves employed by the Knights of St. John.

The Honourable Mr. Gatt, Superintentent of Public Works to the Maltese Government, kindly placed similar facilities at my disposal with regard to gangs of men at work laying sewers during July, August, and September of 1904. The numbers of men employed were 200, 230, and 310, in each month respectively. No case of Mediterranean Fever was detected amongst them.

It appeared to me possible that the men at work in sewer laying had attained a certain immunity from infection, such as is said to be acquired by sewer men at home, and that the opening of the earth might have had a deleterious effect upon the health of the occupants of the houses in the localities where the sewers were being laid.

Curmi, Misida, and Sliema have been sewered during the last few years, the actual period occupied in laying sewers being for Curmi, March, 1901, to October, 1901; for Misida, the whole of 1903; and

for Sliema, November, 1901, to October, 1902. Contrasted with the five-year period 1899 to 1903 there was, as shown below, a slightly greater incidence of Mediterranean Fever in Sliema, and a considerably smaller incidence in Misida during the period that sewers were being laid. In Curmi the incidence was about three times as severe during the laying of the sewers as it was during the five-year period, but here we are dealing with only a very small number of cases. On the whole, the figures below do not indicate that opening streets to lay sewers has any marked effect in increasing the prevalence of Mediterranean Fever.

Table IX.

	I. Period during which work was in progress.	II. Average number of cases of Mediterranean Fever per year per 10,000 inhabitants.	
		During the period set out in Column I.	During the period 1899—1903.
Sliema	Nov., 1901—Oct., 1902	46·9	43·3
Misida	1903	74·4	83·6
Curmi	Mar.—Oct., 1901......	27·6	9·5

(4) *Biting Insects.*—Further investigation is necessary before any definite pronouncement can be made as to the part, if any, taken by biting insects in the spread of Mediterranean Fever. Up to the present little is known as to the life history, distribution, and seasonal habits of even the commoner biting insects found in the Maltese Islands. I have, for instance, evidence that mosquitoes bite in the winter in Malta, but I do not know what kind of mosquitoes do so. The sand fly is very prevalent in parts of Malta during the summer, but there is little information as to his breeding places or his time of flight, or his winter habits.

The researches of Shaw and Gilmour would show that it must be a matter of some difficulty for a biting insect to infect himself from the human subject, seeing the sparse numbers in which the Micrococcus has been found in the peripheral circulation, and the small amount of blood the insect is capable of taking. Similarly, the chances would be infinitesimal of an insect carrying even a single *Micrococcus melitensis* mechanically upon his proboscis. On the other hand, it may be said that if certain biting insects, like mosquitoes, were capable of infecting themselves with Mediterranean Fever and of transferring the infection, the disease would be much more prevalent than it is.

The special incidence upon hospital orderlies, in comparison with hospital patients, is against the biting insect theory. The patients would be more likely to get bitten by infected insects than would hospital orderlies, both on account of being constantly in the wards and because they are less able to defend themselves.

(5) *Water* does not appear to have played any considerable part as a carrier of Mediterranean Fever infection in Malta. The public water supply, which is reasonably free from suspicion of contamination, is laid on to every village in Malta except Mellieha, but most householders have an alternative supply in the shape of a rain-water tank, usually open to contamination. Generally speaking, the public water supply is not laid on to the houses, but is fetched from a stand-pipe, and it is apparent that there is often opportunity for contamination in process of transit, or on account of the place where the water is kept. I personally inspected 100 houses in which Mediterranean Fever had occurred during 1904, and as far as I could judge, 35 of them had a water supply that was not reasonably liable to contamination. Out of 40 houses inspected by way of control, 27 per cent. had a water supply which was not reasonably liable to contamination. In the same two groups of houses, 85 of the infected class used the public water service, while only 65 per cent. of the control class used it.

A comparison between the figures relating to enteric fever, often a water borne disease, and the figures relating to Mediterranean Fever, shows little correspondence in the distribution of the two diseases. For example, the average number of cases of enteric fever per 10,000 inhabitants in Malta per year of the period 1894 to 1903 was 7·2, and the incidence on the three areas referred to previously was as follows:—

Urban area............	7·5 per 10,000 inhabitants	per annum	
Suburban area	6·6	,,	,,
Rural area	6·9	,,	,,

I do not profess to account for this distribution of enteric fever, but it is obviously entirely different from that of Mediterranean Fever.

No connection has ever been demonstrated between any particular branch of the public water supply, nor between any particular well or tank, and an outbreak of Mediterranean Fever, though such connection has frequently been shown with outbreaks of enteric fever in Malta.

Aërated waters are much drunk in the summer time in Malta, but here the question is still one of water. The manufacture is carried on under Government inspection; the water used is generally the public water supply, and in some cases distilled water. No connection has ever been traced between aërated waters and Mediterranean

Fever; indeed, the majority of rural dwellers who are attacked by Mediterranean Fever seldom take aërated waters. The urban and suburban areas, where aërated waters are most taken, do not show a higher incidence of the disease than the rural area.

(6) *Milk* is not so closely connected with water in Malta as it is in most other countries, because the great majority of people get their milk supply in their own vessels direct from the goat.

My inquiries as to the precise source of milk supply in the houses I visited seldom elicited definite information; many of the persons interrogated did not know whose goats supplied them, being in the habit of hailing the first goat herd who passed the door.

More particular inquiries as to sources of milk supply in relation with Mediterranean Fever are now being made immediately upon notification, and when the results are tabulated at the end of July, 1905, some definite pronouncement may be possible.

(7) *Uncooked Foods.*—Inquiry was made in a large number of cases with regard to fruits and vegetables, or salads, but nothing tending to incriminate these articles of diet was elicited.

(8) *Infection by Cuts or Abrasions.*—No connection was established between breaches of continuity in the skin and subsequent attacks of Mediterranean Fever. Practically none of the cases I saw hàd a history of cuts or other abrasions. The only evidence that seems to point in the direction of infection of this kind is the severe incidence of Mediterranean Fever upon patients in the operation ward of the Royal Naval Hospital, Bighi, during 1904, a point which requires further investigation.

The following table gives some idea of the arrangement of the Royal Naval Hospital at Bighi, and the number of patients who developed Mediterranean Fever during 1904, more than 14 days after admission, or less than 14 days after discharge from the hospital.

The chief contributory wards were: C, the operation ward, and D, one of the suppuration wards. Cases were transferred from C to D, if suppuration supervened, and cases were also transferred, when necessary, from D to C. During 1904 seven cases were transferred from C to D, and five from D to C, so that the two wards were in a measure connected with one another. Only one case occurred in E3 or E4, which adjoin the Mediterranean Fever wards and open into them.

	Jan.		Feb.		Mar.		Apr.		May.		June.		July.		Aug.		Sept.		Oct.		Nov.		Dec.		Total.	
—	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks.	Admissions.	Attacks	Admissions.	Attacks.
SURGICAL.																										
North block—																										
A (basement), venereal	15	—	10	—	8	—	13	—	27	—	19	—	20	—	8	1	9	—	13	—	21	—	1	1	164	2
C (1st floor), operations	10	1	5	4	8	—	27	—	3	—	—	—	6	—	3	—	3	—	15	1	18	—	—	1	98	7
E (2nd floor), suppuration	8	1	10	—	8	—	—	2	20	—	18	—	13	—	1	—	1	—	—	—	—	—	—	—	79	3
South block—																										
B (basement), venereal	25	—	11	1	11	—	28	1	—	—	—	—	35	—	3	—	—	—	21	1	20	2	3	1	157	6
B2 (basement), ophthalmic	5	—	5	—	1	—	2	—	10	—	4	—	4	—	—	—	—	—	3	—	1	—	1	1	36	1
D (1st floor), suppuration	7	1	8	2	10	—	16	1	7	—	—	—	11	—	7	—	6	—	22	—	19	6	2	2	115	12
F (2nd floor), suppuration	8	—	—	—	—	—	18	—	12	—	10	—	7	—	—	—	—	—	—	—	5	—	3	—	65	0
Officers' cabins	4	—	1	—	4	—	6	—	4	—	35	—	2	—	—	—	—	—	4	—	9	—	1	—	70	0
MEDICAL.																										
East block—																										
1. Mediterranean Fever	—	—	1	—	1	—	2	—	—	—	—	—	2	—	19	—	8	—	25	—	11	—	2	—	71	0
2. Mediterranean Fever	1	—	1	—	1	—	8	—	7	—	8	—	7	—	10	—	—	—	15	—	1	—	—	—	59	0
3. Enteric and scabies	7	—	5	—	4	—	9	—	2	—	—	—	3	—	—	—	—	—	12	—	12	—	1	—	55	0
4. Zymotics	—	—	—	—	8	—	4	—	2	—	3	—	3	—	1	—	—	—	3	—	—	—	—	1	24	1
Officers' cabins	10	—	9	—	12	—	13	—	11	—	6	—	14	—	10	—	6	—	17	—	4	—	1	—	113	0
West block—																										
1. General medical	42	—	56	—	43	—	51	—	35	—	27	—	62	1	18	—	10	—	45	—	40	2	7	—	436	3
2. General medical	1	—	—	—	6	—	17	—	16	—	—	—	25	—	—	—	—	—	—	—	—	—	—	—	65	0
3. Tubercle	5	1	1	—	9	—	1	—	2	—	—	—	—	—	6	—	—	—	9	—	2	—	—	—	35	1
4. Tubercle																										
Officers' cabins																										

Part III.—Outbreak of Mediterranean Fever in the 2nd Battalion of the Essex Regiment.

This was the only definite outbreak of Mediterranean Fever that I had an opportunity to observe personally, during my stay in Malta.

The 2nd Battalion of the Essex Regiment arrived at Malta from England on April 29, 1904. With the exception of some details sent to Gozo, the regiment was quartered at Lower St. Elmo Barracks, in Valetta until May 19th, when it went to Pembroke Camp for musketry. It remained at Pembroke Camp until May 28th, and then went on to the camp at Mellieha, whence it returned to Lower St. Elmo on June 10th. It was still at the last-named barracks at the end of September.

The first known cases of Mediterranean Fever in the battalion occurred on June 10th, when two sergeants fell ill, another went sick on the 11th, a corporal and a sergeant on the 14th, and so the cases kept dropping in until, on August 27th, there had been 35 cases, 21 of which were directly connected with the sergeants' mess.

The type of the disease was very severe. Cases 4, 9, and 13 died and others were still in danger at the end of September.

Table XI shows the number of known cases of Mediterranean Fever in the Essex Regiment and the date of onset of the disease in each instance.

Of these 35 cases, occurring in $2\frac{1}{2}$ months, 21 were directly connected with the sergeants' mess; as regards the remaining 14, indicated in the table by a star, there does not appear to have been such connection except in the case of No. 12A. This man, however, returned to Gozo on June 10 to find his wife and child sickening with Mediterranean Fever. The probability of his having been infected by his wife or child, or from the same source as they were, seems stronger than the probability of his having been infected while with the regiment. I have therefore not included him amongst the cases likely to have been infected at the sergeants' mess.

Case 20 was in hospital with simple continued fever during most of the regiment's stay at Pembroke, and he returned to duty at St. Elmo instead of going to Mellieha. He left St. Elmo before the regiment's return, and went to Ghain Tuffieha Camp, and from there to Gozo, where he was attacked by Mediterranean Fever. His illness has therefore no causal relation with the main part of the regiment.

The 21 cases connected with the sergeants' mess form a continuous series of 19 attacks in six weeks, with never more than three or four days' interval. After July 16 there is an interval of 11 days

Table XI.

No.	Date of onset.	Name.	Remarks.
1	June 10	Sergt. H.	
2..	,, 10	,, B.	
3..	,, 11	,, W.	
4..	,, 14	Lance-Sergt. H.	
5..	,, 14	Corpl. J.	Used to go into sergeants' mess for orders.
6..	,, 17	Sergt. L.	
7..	,, 20	Pte. M.	Waiter in sergeants' mess.
* 8..	,, 21	,, H.	No connection shown with sergeants' mess.
9..	,, 23	Sergt. F.	
10..	,, 23	Lance-Sergt. S.	
11..	,, 24	,, B.	
12..	,, 25	,, B.	
*12A	,, 25	,, W. ..	Wife and child had Mediterranean Fever at Gozo, where he rejoined them June 10.
13..	,, 28	,, Y.	
*14 .	,, 29	Pte. F.	No connection shown with sergeants' mess.
15..	July 1	Sergt. P.	
16..	,, 1	,, F.	
17..	,, 4	,, M.	
18..	,, 5	,, V.	
19..	,, 7	,, K.	
*20..	,, 8	Pte. P.	,, ,, ,, ,,
21..	,, 12	,, M.	Waiter in sergeants' mess until May 28, 1904.
*22..	,, 15	,, L.	No connection shown with sergeants' mess.
23..	,, 16	Lance-Corpl. B.	Cleaned men's latrines; was often in sergeants' mess for odd jobs.
*24..	,, 23	Pte. H.	No connection shown with sergeants' mess.
25..	,, 27	,, L.	Waiter in sergeants' mess.
26..	,, 31	Sergt. H.	
*27..	Aug. 5	Lance-Corpl. S.	No connection shown with sergeants' mess.
*28..	,, 10	Pte. W.	,, ,, ,, ,,
*29..	,, 13	,, C.	,, ,, ,, ,,
*30..	,, 13	,, C.	,, ,, ,, ,,
*31..	,, 14	,, C.	,, ,, ,, ,,
*32..	,, 18	,, S.	,, ,, ,, ,,
*33..	,, 26	,, A.	,, ,, ,, ,,
*34..	,, 27	,, W.	,, ,, ,, ,,

without a fresh case, and then follows Case 25 on July 27, and four days later, on the 31st, Case 26. There were no other known cases among persons connected with the sergeants' mess up to the end of September, when I left Malta.

As nearly as could be ascertained there were about 60 persons connected with the sergeants' mess, while there were in all 616 men

and officers at Mellicha. Of the 60 persons, 21 were attacked by Mediterranean Fever, while of the remaining 556 persons, 14 only were attacked, and these for the most part at a later period than members of the mess in question.

A short description of the three places occupied by the regiment between April 29, the date of their arrival from England, and the end of September, is as follows:—

Pembroke Camp is the chief musketry camp for the island. It is situated a few miles north of Valetta on the sea shore. The camp is on rocky ground sloping to the sea. The rock is the common calcareous sandstone of Malta, and the intervals between the outcrops are filled by a sandy red loam, which easily pulverises and forms dust.

Mellieha Camp is situated on the bay of the same name, about half-a-mile north of the village of Mellieha, the most northerly village in Malta. The soil in and around the camp is loose and sandy, overlying the upper coralline limestone. The sergeants' mess, a wooden building, is on the edge of the camp, just above a steep sandy slope leading down to the sea.

Lower St. Elmo is a part of the fort which occupies the seaward end of the tongue of land on which Valetta is built. The barracks are below the level of the outer ramparts. The fort is built entirely on the calcareous sandstone.

Both at Pembroke and at Mellieha the regiment was under canvas. An examination of the situation of the tents in which persons attacked by Mediterranean Fever had slept, showed no considerable incidence on any one part of the camp more than on another.

At Pembroke the sergeants messed in a marquee which was equally exposed to the dust with the tents in which the privates lived and ate their food. The marquee stood upon similar soil to the tents, and it was subject to the same conditions with regard to proximity to latrines and urine tubs. It was no more liable to foul air emanations than the tents of the privates. At Pembroke the same latrines (dry earth) were used by the sergeants and by the privates, though a portion was reserved for the former. Complaints were made of offensive smell and of flies at the latrines.

At Mellieha the sergeants' mess hut stood some 40 yards away from the tents of the men. It was a wooden building, raised from the ground on posts, and protected from dust by windows. Built on to it were two water-closets, which were not used during the regiment's stay, because they were said to be out of order. These closets were directly connected with the sergeants' mess room by a louvred ventilator. I found after inquiry on the spot, that these water-closets had become unsealed owing to evaporation. It was therefore possible for sewer air to escape into the mess room from the whole length of sewer below the closets, and from the septic tank to which

this sewer conveyed the sewage of the camp. There were separate latrines (water carriage) for the sergeants and the privates at Mellieha; no complaint of smell or nuisance was made as regards either set of latrines.

At St. Elmo the sergeants' mess was situated on a site elevated some 30 feet above the barrack yard across which it faced the men's barrack rooms, at a distance of 40 or 50 yards. The mess was approached by a path seldom used for any other purpose, and the latrines were on the same level as the mess room, about 10 yards distant from it. I found no fault with these latrines other than the faults inherent to their pattern, which I have already discussed; but the latrines for privates in the same barracks were insufficiently flushed and most offensive.

No duty could be heard of which was likely to bring the sergeants of the regiment together into one place, except that of marking at the butts. (There were butts at Pembroke, but not at Mellieha, or St. Elmo.) There were, however, as many corporals and privates employed at the butts as sergeants, yet there was no special incidence of Mediterranean Fever on the former as there was on the latter.

The only places frequented by sergeants, but not by privates, were, at Mellieha and St. Elmo, the sergeants' mess and latrines, at Pembroke, and the sergeants' mess.

The sergeants who were attacked by Mediterranean Fever seem to have been infected roughly in proportion to the amount of time spent in the mess. The married sergeants would frequent the mess at Pembroke and Mellieha equally with the unmarried ones, while at St. Elmo they would spend more of their time at the married quarters. Twenty out of 51 sergeants who frequented the mess at all three places were married. Six of them were attacked before June 25, of whom three were married (the presumption being that cases before the 25th were infected at Mellieha or Pembroke), while of the remaining 12 cases, infected presumably at St. Elmo, only three were married. The number of cases before the 25th is, however, too small to allow of any great importance being attached to the increased incidence on married sergeants before that date.

Supposing, however, that the sergeants' mess, including, at Mellieha and St. Elmo, the sergeants' latrines, afforded the conditions for contracting infection, the question arises as to whether the mess at Pembroke, that at Mellieha, or that at St. Elmo, was chiefly concerned. The first cases occurred on the 14th day after the regiment left Pembroke. This allows time for an incubation period consistent with the supposition that the disease was contracted at Mellieha, and to a corresponding extent tends to exculpate Pembroke, though it remains possible, of course, that the first few cases became infected at Pembroke. At Mellieha there were circumstances which differentiated the condi-

tions of life at the sergeants' mess from the conditions obtaining in the camp generally, but at Pembroke the same kind of difference did not exist. Some such differences as those obtaining at Mellieha deserve attention in attempting to account for the enormous excess of incidence upon persons connected with the sergeants' mess. Upon the whole, I think it is not likely that the sergeants' mess at Pembroke was seriously, if at all, concerned in the spread of the fever in the regiment, and that it is likely that the cause of the outbreak operated first of all at Mellieha. It would appear certain, however, that the sergeants' mess at St. Elmo had later on a share in spreading the infection, because if we were to suppose that infection was spread only at Mellieha, the average incubation period for Cases 13, 15, 16, 17, 18, and 19, would amount to at least 23 days, and to much more if Cases 21, 23, 25, and 26, were also referred to Mellieha. Although very long incubation periods have occasionally been reported, yet a succession of cases having so lengthened an incubation as the above, seems to me very improbable. I refer here only to the cases connected with the sergeants' mess, the other 13 cases occurring as they did most of them later on, and amongst over 500 men, did not show an incidence much greater than is to be expected under ordinary circumstances in Malta.

Food and Drink.—Bread, water, and milk came to sergeants and privates from the same sources. Butter, fruit, vegetables (salads, tomatoes, etc.), were eaten by both. Mineral waters were drunk by both, but those drunk by the sergeants were said to be made from distilled water, while those supplied to privates were not.

More precise inquiries were made amongst the members of the sergeants' mess and persons connected with it, including those of them who were ill with Mediterranean Fever.

Water.—Inquiry was made of 52 men connected with the sergeants' mess, including 19 of those attacked by the fever, as to water drinking. Cases 5 and 23 were not included because they neither ate nor drank in the sergeants' mess. Thirty-one men never drank water, and one other man only drank it on one occasion, and may for practical purposes be considered a non-water drinker. Of these 32, 11 were attacked (34·4 per cent.). Eleven men seldom drank it, and seven of these were attacked (63·6 per cent.). Nine men habitually drank water, and one was attacked (11·1 per cent.). Non-water drinkers then were attacked at the rate of 34 per cent., while water drinkers (habitual and occasional) were attacked at the rate of 40 per cent. On the other hand, occasional water drinkers were attacked nearly six times as severely as habitual water drinkers. The 11 occasional water drinkers drank it only when employed at the butts, when they obtained it from their water bottles. The habitual water drinkers also drank at the butts, in the same way, water from a like source.

Milk.—As result of inquiry made of 58 men connected with the sergeants' mess, it appeared that 3 drank unboiled milk by itself, and that 1 of them was attacked (33·3 per cent.); while of 55 men who did not drink unboiled milk by itself, 17 were attacked (30·9 per cent.). Case 4 was too ill to be interrogated, and is consequently excluded.

Milk with tea, coffee, or cocoa, was taken by all except three men. None of these three were attacked.

Mineral Waters.—Two out of 59 men interrogated did not drink mineral waters. One of these two was attacked.

Beer.—Of 59 men interrogated, it was ascertained that 52 took beer, and 17 of them were attacked (32·7 per cent.); while of 7 that did not take beer, 2 were attacked (28·6 per cent.).

Raw Vegetables (tomatoes, salads, etc.) were eaten habitually by 42 men out of 59, seldom by 9 men, and never by 8 men. Of the 51 who ate raw vegetables 14 were attacked (27·5 per cent.), while of the 8 men who did not eat them 5 were attacked (62·5 per cent.). Of the 14 cases among eaters of raw vegetables, 12 occurred among the habitual consumers and 2 among the occasional consumers.

Fruit.—Uncooked fruit was eaten habitually by 38 men out of 58, seldom by 13 men, and never by 7 men. Ten of the 38 who eat fruit habitually were attacked (26·3 per cent.). Four of the 13 men who seldom eat fruit were attacked (30·8 per cent.), and 5 out of the 7 who never ate it were attacked (71·1 per cent.).

Bread and Butter were partaken of by all from a like source.

It cannot be said that any one of the foods or drinks inquired about is incriminated by the above details, nor can there be much doubt that if any of the foods or drinks had been largely concerned in spreading the disease, the fact would have appeared. There is a slightly greater incidence upon those who drank water, but not sufficient, in face of the small numbers dealt with, to found any conclusion upon.

Bathing.—Inquiry was made as to bathing, because it has frequently been suggested that Mediterranean Fever might be caused by bathing in sewage-polluted waters. At Mellicha the sewage from the camp is discharged into the shallow waters of the bay, after passing through a septic tank, and at St. Elmo, situated as it is on the point separating the Grand and Quarantine harbours, there is considerable pollution of the water by sewage. Out of 64 men interrogated, 58 bathed and 19 were attacked (32·8 per cent.), while of 6 men who did not bathe, 2 were attacked (33·3 per cent.).

Personal Infection.—The question of direct personal infection from man to man was considered. This may have occurred in the mess-room, but if so, why did it not also occur outside from sergeants to men? unless, indeed, it happened that infection was largely conveyed from man to man by means of spray thrown into the air in the act of speaking or coughing. This method of infection would no doubt be favoured

by the still air of the mess room, and by the propinquity therein of the sergeants to one another during conversation; it would not be so likely to operate in the open air, nor perhaps in the tents or barrack rooms at night. If direct personal infection, other than through saliva, were the mode of infection in this outbreak, it would have better opportunity for taking effect in the tents and barrack rooms at night than in the mess room. Many of those attacked by Mediterranean Fever slept in tents with other persons not connected with the sergeants' mess. For instance, 7 privates slept in the tent with Case 12 at Mellieha, and 21 privates in the same room with him at St. Elmo. Most of the unmarried sergeants who fell ill at St. Elmo slept in bunks in the room with 20 or more men, yet none of these men were infected. Five cases altogether occurred in persons who had slept in the same tent or room with earlier cases, and 3 of the 5 were connected with the sergeants' mess.

Biting Insects.—In view of the theory put forward by Zammit, inquiry was made of 58 men connected with the sergeants' mess as to whether they had been bitten by mosquitoes or sand flies. It was considered at the time that the answers received would probably be a better index of the toughness or insensibility of the deponent's skin, than of the facts as they really were; nevertheless the results are given for what they are worth. Forty-three men were conscious of having been bitten, and 7 of them were attacked by Mediterranean Fever (16·3 per cent.); while of 19 who were not aware of having been bitten, 11 were attacked (57·9 per cent.). These figures may be claimed as unfavourable to the hypothesis that biting insects play a part in the transmission of Mediterranean Fever to man. On the other hand, it may be contended that those who were not aware of having been bitten had the more insensible skins, and hence were less likely to take precautions with a view to preventing the insects biting them, and, in consequence, were the more likely to have been bitten. Cases 4, 9, and 13 were too ill to answer this interrogation, and are consequently excluded.

If infection were conveyed by a biting insect, the insect, to fit in with the circumstances of this outbreak, would require to be one which did not bite in bright sunlight, nor in the dark. It was practically only in bright sunlight or in the dark that the sergeants mixed with the men, and if the insect were in the habit of biting under these conditions, the men would have been infected as well as the sergeants. Again, the insect must be one likely to confine itself strictly to one building or marquee, seldom or never wandering 50 yards away, for at Pembroke, Mellieha, and St. Elmo the tents or barrack rooms were within 50 yards of the sergeants' mess.

It may be asked how would the insect be likely to have become infected. Mellieha Camp was occupied from May 3 to June 9 by three different regiments, but no case of Mediterranean Fever is

known to have occurred amongst them during their stay or 14 days after. Neither were any cases reported from Mellieha village during this period. The possibility, however, of there having been unrecognised cases of Mediterranean Fever in one of these regiments, or in the Essex Regiment, cannot be disregarded.

It should be noted that non-commissioned officers would provide better opportunity for the spread of personal or insect-borne infection, than would private soldiers. The former are always loth to go to hospital, and usually defer reporting themselves sick until the last possible moment, while the latter generally report at once. In this outbreak, for instance, Case 6 did not go into hospital until July 15, although he became ill on June 17.

The only biting insect, of which I am aware, that comes at all near fulfilling the conditions which this outbreak seems to require is the female *Stegomyia fasciata.* There is, however, at present, wide divergence in the views of various observers as to her flight and habits of biting. It would be remarkable if so short a distance as 50 yards proved an insuperable barrier for a winged insect, even for one which, like the Stegomyia, is generally supposed not to wander far. Specimens of the Stegomyia were to be found at the time at Mellieha and St. Elmo, but they were also to be found at Valetta Station Hospital into which all the cases were removed. In this hospital Mediterranean Fever patients were separated from other patients only by a partition 9 or 10 feet high, in a ward more than 20 feet high, and mosquito nets were not in general use, and yet it does not appear that other patients became infected specially at that time.

Latrines in Connection with the Outbreak.—In view of Horrocks' discovery that the *Micrococcus melitensis* is excreted in the urine, and the possibility that it is also excreted in the fæces, the question arises, supposing that infection were spread by the sergeants' mess at Mellieha and St. Elmo, was it spread principally by way of the mess room, or by the latrines? The latter, it will be remembered, were separate from those of the privates both at Mellieha and at St. Elmo. I am not now considering the disused water-closets at Mellieha. Both the latrines and the mess room were used by everybody connected with the sergeants' mess, except Cases 5 and 23, so that it is difficult to find any evidence to incriminate the one place as against the other. It can be said, however, that it is difficult to imagine an infection inherent to the mess room yet not likely to be conveyed directly from man to man outside, while if the infection be supposed to be inherent to the latrines and of excretal origin, the difficulty is not nearly so great: infected dust, due to the pattern of the latrines, or infection of the hands and thence the mouth or nose for instance. Against the possibility of the latrines having been principally concerned in the spread of infection is the following negative evidence

which is not of sufficient weight to be at all conclusive:—One and the same man attended to the flushing and cleansing of the sergeants' latrines both at Mellieha and St. Elmo, and he was not attacked by Mediterranean Fever. Cases 5 and 23 did not use the sergeants' latrines. In addition it may be said that if the first few cases of the outbreak were infected at Pembroke, where the sergeants used a portion of the same latrines as the men, it would be expected that some of the men would have been infected if the latrines were the source of infection. I have, however, already said that I do not think it probable that the early cases were infected at Pembroke, and the man who attended to the sergeants' latrines may have been immune to Mediterranean Fever.*

With regard to the two water-closets through which it was possible that sewer air obtained access to the sergeants' mess at Mellieha, there appeared to be two ways in which they might have contributed to spread the fever: either by allowing infected dust to enter the mess room, or by allowing sewer air to enter, and thus weakening the natural tissue resistance by causing sore throat, or general loss of tone. None of those attacked by the fever, however, complained of sore throat previous to the onset of the fever. As to the infected dust theory, specimens were procured of the dust in the ventilator and on the closet pan, and were injected into monkeys by Horrocks without producing any ill effect. These specimens were, however, very minute, and were procured some weeks after the regiment left Mellieha. But supposing that infected dust from these closets, or from the latrines, were the cause of fever at Mellieha, what then caused the continuance of the outbreak at St. Elmo? Again, if the general tone of the men's health was lowered by the inhalation of sewer air in the mess room at Mellieha, and they were thus rendered specially liable to Mediterranean Fever, their health should have recovered its normal tone at St. Elmo, other conditions being equal, and the outbreak should have ceased, which was not the case.

Septic Infection.—Inquiry was made of those attacked as to whether they had suffered from cuts or boils, or other skin lesions, before the onset of the fever, but in no case was the reply in the affirmative.

Conclusion.—The available evidence is not such as to justify a definite

* "Carbolic" powder was used as a disinfectant in the latrines from the time of the regiment's arrival in Malta until May 18, when it was discontinued by order of the War Office, on the grounds that it was not a disinfectant but only a deodorant. Its use was resumed by the Essex Regiment on June 20. In view of any question arising as to a connection between the disuse of the "carbolic" powder and the outbreak of fever, a specimen of the powder was examined for me by Horrocks, and he found that a 10-per-cent. solution in urine failed to kill a culture of *M. melitensis* in one hour. I do not therefore think that the use, or disuse of the powder can have had any influence on the potentialities of the latrines to spread infection.

conclusion as to the manner of propagation of Mediterranean Fever in this outbreak.

The facts narrated, however, are not without value for the epidemiologist. If they cannot be held to warrant positive assertion of the transmission of the malady by a particular agency, they are at least of service in strongly suggesting the exclusion, in this instance, of certain possible factors, and as regards other such factors, in affording means of considering the relative degrees of probability of their having been concerned with the incidence of the fever.

Regarded in this light, the evidence may fairly be held to indicate that articles of food and drink played no appreciable part in the dissemination of the disease. A like inference is justified concerning the possible influence of conditions associated with bathing, and with inhalation or swallowing of infected dust in the open.

The possibility of the fever having been conveyed by biting insects cannot so readily be dismissed. But a careful review of the facts and conditions adduced under this head does not favour acceptance of the hypothesis that the explanation of this outbreak is to be found in this direction.

The facts reviewed in this report under the heading of direct personal infection are only such as would suggest the transmission of the fever by this agency if the manner of transmission in this instance had been such as almost entirely to limit its operation to the sergeants' mess. I am not, so far, in possession of any facts on the bacteriological side capable of strengthening, or negativing the possibility of transmission of the fever by saliva. I do not know even that the *Micrococcus melitensis* exists in the saliva of patients. It may be said, however, that infection by means of saliva affords a solution of the problem of transmission not inconsistent with the facts in this outbreak, so far as I have been able to discover them; but it must be added that other facts noticed in Part II of this report under the heading "Direct Personal Infection," do not point to the probability of saliva spray having played a part in the spread of infection. (See p. 37 *et seq.*)

There remain for consideration the possibilities of the fever having been transmitted by conditions other than direct personal infection, or conveyance of the disease by biting insects, associated with the latrines of the sergeants' mess, or with the sergeants' mess itself.

Hypothesis that Mediterranean Fever may be a "filth disease," and that the latrines in question became and remained for some time infected by *Micrococcus melitensis*, passed in the urine or fæces of persons using them, would point rather to the latrines having had relation with propagation of the disease than to like relation of the mess itself. Such hypothesis, however, involves considerations that require further investigation, and, without more complete knowledge than is now available, can be no more than tentative.

Besides the condition suggested by this hypothesis, there may be others, at present unknown, which future epidemiological investigation, combined with further acquaintance with the life history and habits of the specific contagion of the malady, may serve to reveal, and which may be found to explain, as regards this outbreak of Mediterranean Fever, the special incidence of the disease upon persons frequenting the sergeants' mess or using their latrines.

These inferences, and the relative degree of probability of each, have relation solely to this particular outbreak of Mediterranean Fever. Even did the evidence point conclusively to one particular agency as being solely concerned with the outbreak, it would not necessarily follow therefrom that such agency would have to be regarded as the only one having concern with the transmission of Mediterranean Fever generally.

Part IV.—General Summary and Conclusion.

Hampered by a sense of the inaccuracy of the civil notification returns, I have only attempted to draw the most general conclusions from them, except with regard to the seasonal incidence.

The evidence I have been able to collect is not sufficient to lead to any final conclusion. I hope, however, that I have been able to indicate in the course of Part II some directions in which further epidemiological investigations would be likely to prove profitable.

The distribution of Mediterranean Fever amongst the civil population goes to show that, outside certain paved and drained areas, aggregation of persons in one locality, and density of population upon area in a district, favour the spread of the disease. The distribution amongst the garrison depends mainly on the age of the men and their length of service in Malta, new arrivals and young men being more frequently attacked. As regards the Navy, I have only been able to obtain figures for three years. So far as they go, they tend to show that, when a ship is invaded in one year, it is also invaded in each successive year, if it remain on the station.

The incubation period seems, on the data I have been able to collect, to be about 14 days, but further evidence is necessary before a definite conclusion can be reached.

As to the mode of entry of the specific infection into the human body, the facts do not permit of a definite pronouncement. The evidence, so far as it goes, seems to show that food and drink have no marked connection with the spread of the fever. Newly turned earth falls into a like category.

As a whole, the facts do not indicate that dust infection, outside dwellings, or direct personal infection by contact, breath, or saliva, plays an important part in spread of the disease, but there is not evidence to justify the exclusion of any of these factors.

I have been able to collect little evidence either for or against the carriage of infection by biting insects.

The facts with regard to infection by means of excretal pollution of the hands, the food or the dust in houses, so far as I have been able to deal with them, are suspicious, but they are not sufficiently strong to justify any conclusion.

Some reform of the notification system in Malta is necessary before epidemiological investigation can be expected to produce the best results. In addition, facts must be collected and recorded immediately after their occurrence by competent observers. Such work cannot be adequately performed by the sanitary inspectors as at present trained in Malta.

I have endeavoured to provide for the immediate record of a certain number of facts in relation to cases of Mediterranean Fever during the year ending July 31, 1905, amongst the civil population, and in the Services. With regard to the former, I fear that laxity of notification will prove a stumbling block. I regret that an urgent invitation to the Maltese medical men to forward blood samples to the public health laboratory for confirmation, did not meet with the response I expected.

I hope, however, that the facts now being recorded may prove useful in the consideration of some points.

In the meantime, I am still in process of receiving information from Malta which I have requested, as I found it necessary, and I should prefer to await its arrival and the consideration of the facts for the year ending July 31, 1905, before making any recommendations.

I have to thank the following gentlemen for much help and information given me in the course of this inquiry :—Deputy-Inspector Cox, R.N. ; Fleet-Surgeon Bassett-Smith, R.N. ; Staff-Surgeon Gilmour, R.N. ; Colonel Wolesley, R.A.M.C. ; Lieutenant-Colonel Rhodes, R.A.M.C. ; Captain Kennedy, R.A.M.C. ; Lieutenant-Colonel Adair, R.E. ; Lieutenant-Colonel Winter, Director of Supply and Transport ; and Major Boyce, D.S.O. ; the Honourable A. Gatt, Superintendent of Public Works ; the Honourable A. Micallef, Comptroller of Charitable Institutions ; Mr. Cartwright-Reed, Admiralty Superintendent of Works ; the Rev. Father Dobson, S.J., and the medical officers of health of Malta and Gozo.

ON THE SAPROPHYTIC LIFE OF THE *MICROCOCCUS MELITENSIS.*

By Fleet-Surgeon P. W. Bassett-Smith, R.N.

In compliance with suggestions made at the Sub-Committee Meeting of November 27, 1904, I have, at Haslar, carried out independently, during the last three months, some experiments relating to the vitality of the *M. melitensis* outside the body, with special reference to the infection of the soil, clothing, sea and tap-water, through the agency of infected urine. During this time I have not myself been able to isolate the *M. melitensis* from the urine of any clinical case in the wards (most of them being chronic, with relapses), though it was often present in the peripheral blood, and have, therefore, had to employ urine artificially infected; from the experiments it was apparent that the grosser the infection the longer could the organism be recovered from the material infected.

Some check experiments were also made with broth cultures as a means of infection, though in all cases these had been previously cultured for a certain time in human urine, which apparently did not decrease the vitality of the *M. melitensis.*

In proving the results of these experiments, as to purity of cultures, the following tests were carried out:—

1. Microscopical examination for morphological characters.
2. Alkaline reaction with litmus broth and milk.
3. Inability to stain by Gram.
4. Reaction with known serum of a Mediterranean Fever case.

Vitality of the M. melitensis *in Urine.*

Series 1.—The urine employed was that taken from Mediterranean Fever cases, which had been proved not to contain the *M. melitensis*, and had been sterilised on three days, but not otherwise treated.

No. 1.—A considerable quantity of a surface culture on agar of *M. melitensis*, originally obtained from Netley, in 1901, was emulsified with 10 c.c. of sterilised urine from a Mediterranean Fever case. It was kept at a temperature of 22° C.

This was subcultured successfully daily up to the 18th, after which it was not recovered.

No. 2.—Equal quantities of a five day old broth culture of *M. melitensis* and sterilised Mediterranean Fever urine, were mixed and subcultured daily on agar. The organisms gradually died out, and were last detected on the 14th day.

No. 3.—Strongly alkaline urine was infected from an agar culture of *M. melitensis* of three days' growth. Here the organisms more quickly died out, being last recovered on the 12th day.

No. 4.—Sterilised urine of a Mediterranean Fever case was infected from an agar culture, which had been previously passed through urine and sea water. In this case it was not recovered from the urine later than the 9th day. The urine was then very alkaline, equal to standard deci-normal soda sol.

No. 5.—Very slightly alkaline sterilised urine of a Mediterranean Fever case was infected from an agar culture, which had been previously passed through tap-water and urine.

In this the *M. melitensis* was regularly recovered, growing normally up to 41 days, the urine infected remaining perfectly clear, and was only slightly alkaline when the organism died out.

No. 6.—Faintly alkaline sterilised urine, rich in urates, of a case in the ward was infected by an agar culture derived from a sea-water one, inoculated from an artificially infected urine.

In this the *M. melitensis* again retained vitality for an exceptionally long period, viz., 39 days, the last subculture reacting normally in all respects.

Viability in Sea-Water.

Series 2.—These were made with ordinary sea-water taken from the harbour, sterilised, and, after inoculation, placed in the 22° C. incubator, and evaporation prevented.

No. 1.—Ten c.c. of sterilised sea-water was infected from a five-day old agar culture of *M. melitensis* derived from artificially infected urine. In the subcultures the colonies gradually became fewer, the last being found on the 26th day.

No. 2.—Ten c.c. of sterilised sea-water was infected with 1 c.c. of seven-day old broth culture of *M. melitensis*, which had been derived from artificially infected urine. From this the last successful subculture was made on the 21st day, when the tube was accidentally broken.

No. 3.—Ten c.c. of sterilised sea-water was infected with 1 c.c. of slightly alkaline urine strongly infected with *M. melitensis* derived from artificially infected urine, that is, two passages through urine; subcultures gave abundant growth until 30 days, when it appeared to die out rapidly, the last being obtained on the 34th day.

Viability in Tap-Water.

Series 3.—These were made from sterilised tap-water of the laboratory after inoculation, being kept in 22° C. incubator.

No. 1.—Ten c.c. of sterilised tap-water was infected from an agar

culture of *M. melitensis* derived from artificially infected urine. The last successful subculture was obtained on the 23rd day.

No. 2.—Ten c.c. of sterilised tap-water was infected with 1 c.c. of a seven-day old broth culture of *M. melitensis* derived from artificially infected urine. Growth was obtained up to the 18th day, when the tube became contaminated.

No. 3.—Ten c.c. of sterilised tap-water was inoculated with 1 c.c. of slightly alkaline urine freshly infected with *M. melitensis* which had been grown in urine. Growth was obtained abundantly until the 26th day, the last being obtained on the 30th.

Viability in Fabric which had been Infected, and Dried in Hot Incubator.

Series 4.—Small squares of flannel fabric were used. These were soaked for certain periods in the culture, drained, and then dried slowly in the hot incubator.

No. 1.—The squares of fabric were immersed for 24 hours in a broth culture of *M. melitensis*, then dried as above stated. One of these was removed every three days, placed in broth, and finally subcultured on agar. Recovered for 37 days.

No. 2.—Immersed for a quarter of an hour in infected urine. Recovered for 7 days only.

No. 3.—Immersed for half an hour in grossly infected urine. Recovered for 15 days.

No. 4.—Squares soaked for 24 hours in urine (Series 1, No. 5) on 10th day of growth. *M. melitensis* recovered for 26 days. The squares soaked became discoloured and stiff from impregnation with urinary constituents.

No. 5.—Squares soaked in infected sea-water for 12 hours. No growth obtained on the 7th day.

Viability in Artificially Infected Dust.

Series 5.—Fine bath brick dust was sterilised, and then soaked for one hour in infected media, drained, and dried in hot incubator. Subcultures were regularly made from this with litmus broth, and finally from this agar cultures, and tested for purity.

No. 1.—Fine oolitic dust infected for one hour with five-day old broth culture, derived from artificially infected urine. *M. melitensis* recovered for 25 days.

No. 2.—As above. *M. melitensis* recovered for 26 days.

No. 3.—Oolitic dust infected with seven-day old broth culture derived from infected urine. Growth abundant and typical. Recovered up to 36 days.

No. 4.—Oolitic dust soaked in slightly alkaline sterilised urine,

grossly infected with *M. melitensis.* Growth was recovered for 30 days.

No. 5.—Oolitic dust soaked in urine in which *M. melitensis* was growing feebly. Not recovered on 3rd day, or any date after.

Series 5A.—Road dust with vegetable and other *débris* collected and thoroughly sterilised, and tested by control cultures. Treated in similar manner to oolitic dust.

No. 1.—Road dust infected by soaking in five-day old broth culture of *M. melitensis* derived from artificially infected urine. Recovered for 44 days.

No. 2.—Road dust soaked in urine strongly infected with *M. melitensis.* Recovered for 16 days.

No. 3.—Road dust soaked in urine in which *M. melitensis* was growing feebly. Not recovered on 3rd day, or any subsequent date.

No. 4.—Road dust infected with urine and broth culture of *M. melitensis* in equal parts. Recovered for 8 days only.

Table of Results of Vitality of the *M. melitensis* outside the Body.

Medium tested.	Source of supply.	Number of days on which the *M. melitensis* was recovered.
Urine, sterilised	Agar culture	9
	,,	12
	,,	18
	,,	39
	,,	41
	Broth culture	14
Sea-water, sterilised	,,	21 (tube broken)
	Agar culture	26
	Infected urine	34
Tap-water, sterilised	Agar culture	23
	Broth culture	18 (contaminated)
	Infected urine	30
Fabric, infected and dried	,, ¼ hour	7
	,, ½ ,,	15
	,, 24 hours	26
	Broth culture 24 ,,	37
	Sea-water 12 hours	Less than 7
Dust, oolitic, infected and dried	Broth culture	25
	,,	26
	,,	36
	Infected urine (strong)	30
	,, (weak)	Under 3
Road dust, infected and dried	Broth culture	44
	Infected urine (strong)	16
	,, (weak)	Under 3
	Urine and broth	8

OBSERVATIONS ON THE VIRULENCE OF *MICROCOCCUS MELITENSIS* FOR THE GUINEA-PIG.

By J. W. H. Eyre, M.D., F.R.S. Edin., Lecturer on Bacteriology in the Guy's Medical and Dental Schools, Bacteriologist to Guy's Hospital, etc.

Summary.

The Pathogenic Action of M. melitensis.

The degree of virulence possessed by *M. melitensis* for such rodents as the rabbit and guinea-pig is naturally exceedingly low, and in order to produce a fatal infection in these animals, it is necessary to introduce enormous numbers of cocci subcutaneously or intraperitonally; even then the infection follows a protracted course, and weeks or even months may pass before death takes place.

The majority of the animal experiments by early observers was carried out upon the monkey, an animal which, as originally shown by Bruce,* and afterwards by Hughes, can be easily and certainly infected, chiefly for the reason that attempts to produce fatal infection in the usual laboratory rodents (the rabbit, guinea-pig, and mouse) were for the most part unsuccessful, certainly no appreciable increase in virulence could be demonstrated.

In 1898, however, Durham† applied the method Catani had used to

* Bruce, "Sur une nouvelle forme de fièvre rencontrée sur les bords de la Méditerranée, 'Annales de l'Institut Pasteur,' vol. 7, 1893, pp. 289—304; 'Practitioner,' 40, 1888, p. 241; Hughes, "Investigations into the Etiology of Mediterranean Fevers," 'Lancet,' vol. 2, 1892, p. 1265.

† Durham, "Some Observations on the *Micrococcus melitensis*" (of Bruce), 'Journ. of Path. and Bact.,' vol. 5, December, 1898, pp. 377—388.

raise the virulence of the influenza bacillus to *M. melitensis*, and was able to show that the natural resistance of both the rabbit and the guinea-pig was much more readily overcome if the Micrococcus was introduced directly into the brain substance. Further, by a short series of intra-cerebral passages, he succeeded in slightly raising the virulence, as will be seen from an inspection of the accompanying table, which is compiled from his paper.

Table I.

Animal.	Inoculation.	Dose.	Mode of infection.	Result.
1. Rabbit....	Large quantity of cocci from agar plate suspended in 4 c.c. of a 4-day broth culture	0·5 c.c.	Intracerebrally	Died 4th day.
2. Guinea-pig	—	0·3 ,,	,,	Ill from 3rd to 10th day; recovered. Killed at 4 months.
4. Guinea-pig	5-day agar culture from Rabbit 1	1·5 loop (3 mgrms.)	,,	Died 6th day.
5. Guinea-pig	Agar culture from Guinea-pig 4	1 loop (2 mgrms.)	,,	Died 4th day.

The rise in virulence for the guinea-pig resulting from one passage through the rabbit is remarkable; but it will be seen that the additional passage through Guinea-pig 4 did not cause any appreciable effect—the fact that a slightly smaller dose was fatal to Guinea-pig 5 might be readily explained on the ground of that animal's greater susceptibility, *e.g.*, a younger or a smaller animal—a contention which is supported by the observations that in subsequent inoculations 2 and 1 loop (*i.e.*, 4 and 2 milligrammes) were fatal respectively in four and six days.

This feeble virulence for the guinea-pig combined with the tardy growth of *M. melitensis* upon artificial media renders it a matter of some difficulty to estimate the amount, or indeed the presence of protective bodies in the serum of animals treated with cultivations of the organism—so troublesome a process in fact, that after attempting, during the early part of last year, to prepare an anti-serum from the goat, I suspended my experiments in favour of an inquiry into the possibility of exalting the virulence of the micrococcus.

In view of the results of Durham's observations, I decided to limit my endeavour to exalt virulence for the guinea-pig to the intra-cerebral method of inoculation, and to employ, at first, one strain only of the *M. melitensis* in my experiments. The result was distinctly encouraging, for after rather more than a score of passages a very considerable access of virulence was obtained.

Before giving the details of these passages, a few points concerning the organism used and the methods followed may be of interest.

Organism Employed.—M. melitensis "*No.* 5."

Origin.—Isolated from the pus during life, and subsequently from the spleen (*post-mortem*) of a fatal case of subdiaphragmatic abscess* occurring in Guy's Hospital during October, 1903.

Morphology and Cultural Characters quite typical.

Initial Virulence for the Guinea-pig.—When first isolated, three entire four-day agar cultivations (*vide infra*) emulsified in 0·4 c.c. sterile saline solution, injected intracerebrally, were required to cause death—the fatal termination ensuing about 25 days after inoculation.

Medium Used for Growth of Virulence Cultures.

Previous experiments of my own, no less than the experience of other observers, show that fluid media are quite unsuited for the growth of, what I may term "Virulence Cultures." In the first place, growth in, for example, nutrient broth is extremely slow, and does not reach its maximum until the 6th to 8th day: then, too, the cranial capacity of the guinea-pig is small, and if the dose of culture exceeds or even amounts to 0·5 c.c., either some of the inoculated fluid at once escapes, or severe pressure symptoms supervene, and the animal dies within a few minutes.

A cultivation upon a solid medium, on the other hand, affords the opportunity of concentrating a large amount of the infective material in a bulk sufficiently small to ensure retention of the entire dose within the cranial cavity, without causing the exhibition of pressure symptoms, by scraping off large numbers of cocci and emulsifying in minute quantities of sterile saline solution.

Some observations upon the cultural characters of *M. melitensis* made during last summer by the writer in conjunction with Surgeon Duncan, R.N., showed that upon ordinary nutrient agar (prepared and standardised to +10, according to the method and scale I have described elsewhere)† *M. melitensis* in subcultivations would develop colonies

* Eyre, "A Case of Subdiaphragmatic and Hepatic Abscess consecutive to Mediterranean Fever," 'Guy's Hospital Reports,' 59, 1905, pp. 207—216.

† Eyre, "Standardisation of Nutrient Media," 'Brit. Med. Journ.,' 2, 1900, p. 921, and 2, 1901, p. 788.

visible to the naked eye in from 24 to 30 hours at 37° C., and would attain the maximum development in from 72 to 96 hours.*

I therefore decided to employ this medium in the form of "slant" tube cultures, filling the medium in quantities of 10 c.c. into tubes specially selected to secure uniformity of size, and always slanting the medium at about the same angle in order to obtain approximately equivalent areas for growth in each culture.

Preparation of Inoculum.

Tubes were inoculated from the spleen of one guinea-pig which had succumbed to intracerebral infection for inoculation into the brain of the next animal of the series, and after 24 hours' incubation at 37° C. were examined naked eye, and microscopically by means of smear preparations. As a rule at this age no definite colonies could be distinguished naked eye, although the inoculated surface of the medium presented a ground-glass appearance, and film preparations always yielded abundant evidence of growth.

After the preliminary examination, a sterile platinum loop was introduced into the tube, moistened in the water of condensation, and then gently rubbed all over the slanted surface of the medium. As the result of this manœuvre, by the third or fourth day the medium was covered with a luxuriant growth, affording ample material for inoculation.

Method of Measuring the Dose of Inoculum.

The terms "entire culture," "half a culture," etc., as applied to dosage have little to recommend them on the score of exactitude, therefore the more accurate method of measurement by "loops" evolved by the late Dr. Washbourn and myself for the estimation of the virulence of the pneumococcus was utilised in the experiments. Briefly, this method consists in using a platinum loop accurately calibrated by weighing experiments; filling it carefully with the culture, and then emulsifying its contents in a definite measured quantity of broth, and using for the inoculation portions of this emulsion, representing fractions of the original loop. The special loop I use is the one originally made for pneumococcus work; its holding capacity had already been estimated to equal 0·5 milligramme of a 24-hour-old blood agar cultivation of pneumococcus; and when re-calibrated for 72 to 96-hour-old agar cultures of *M. melitensis* it was determined to have an identical capacity.

* At the same time I am not prepared to state absolutely that +10 is the *optimum reaction* of the medium to be employed for this purpose, until some experiments that are being carried out now are completed. Still this reaction is undoubtedly close to the optimum, so that in the absence of more definite knowledge I did not feel inclined to deviate from it.

Further, by plating out various fractions of a loopful of 72 to 96-hour-old agar cultivation and enumerating the colonies that subsequently developed, an approximate estimation was obtained of the number of cocci per loopful—that is to say, contained in 0·5 milligramme cultivation.

The average determined from a large series of experiments worked out to 1,250,000,000 cocci per loopful.

Now as in some of the preliminary inoculations more than one "slant" tube culture was required to produce a fatal infection, several observations were made to determine the average number of loopfuls per cultivation. After many trials this was found to be 25; and all the doses in the detailed table of inoculations are calculated as "loops," and so recorded—although in the first few inoculations the figures can only be regarded as approximately correct, for these doses were not measured accurately, on account of their size.

Method of Inoculation.

As the intercranial method of inoculation is not amongst those most commonly practised, some details of the *technique* I adopted may be of interest.

The guinea-pig is first fully anæsthetised by means of a mixture of alcohol, chloroform, and ether, in the proportion of 1 : 2 : 6 (A_1, C_2, E_6), administered on a piece of absorbent cotton-wool placed either in the corner of a folded towel, or in the bottom of a small conical glass beaker.

The animal is then fastened down to the operating table, or firmly held by an assistant, and the hair of the scalp moistened with a solution of soft soap in 2-per-cent. lysol, which, with the help of hot water and cotton-wool, is worked up into a lather. The entire scalp, from the occipital protuberance to the root of the snout, is shaved, and finally washed with warm lysol solution.

A median incision commencing over the occiput and running forwards for about 2 cm., is made through the skin and subcutaneous cellular tissue, and retractors, secured by the assistant, used to hold open the wound. The periosteum is next divided along the entire line of the skin incision, then raised with a blunt dissector and also secured by the retractors.

A small nasal trephine (Curtis's), having a tooth-cutting circle of 6 mm. diameter,* is attached to a dental engine, and a small disc of bone removed from the left parietal bone; this trephine hole is cut well to one side of the median line to avoid injuring the superior

* This instrument has been adapted for me by Messrs. Down Bros. by the addition of an adjustable collar guard, secured by a screw, to prevent laceration of the dura mater or brain substance.

longitudinal sinus, a mishap which gives rise to troublesome hæmorrhage.

A hypodermic syringe provided with a fine needle is used to inject the measured dose of cocci, and some little manipulation is found to be necessary to ensure that the animal receives the entire dose. The injection may be made into any portion of the brain substance, or into the subdural space. Usually I inject into the left cerebral hemisphere, rarely into the frontal region. I avoid entering the cerebellum solely because muscular tremors and twitchings of the entire body are thereby induced which last for some minutes and interfere with the suturing of the skin wound.

The disc of bone is replaced or not, according to circumstances. If the injection appears to have caused any appreciable rise in the intra-cranial pressure, as indicated by protrusion of brain matter and meninges into the trephine circle, I do not replace the bone; otherwise I do. The periosteum is now readjusted as nearly as possible to its original position, and the skin incision closed by means of a continuous suture of either linen or silk, then sealed with flexile collodion. A dressing of sterile absorbent cotton-wool is fixed over the wound with more collodion, and the animal allowed to come round from the anæsthetic. Although the description is lengthy, the operation occupies but little time; given one assistant to attend to animal and the anæsthetic, 10 minutes will suffice from the commencement of the anæsthetisation to the return of the guinea-pig to its cage.

Passages to Exalt Virulence.

For the sake of brevity and clearness, I have tabulated the details of such of my inoculation experiments* as are pertinent to the present inquiry (*vide* Table II), and in this connection I must distinctly point out that my object was in no sense to determine the *minimal* fatal dose of that particular strain of *M. melitensis* I employed, for I take it the minimal fatal dose is the smallest dose which will cause a fatal specific infection after the lapse of no matter how lengthy a period.

Such an inquiry would have required the expenditure of more time than is at the disposal of any one man, for Durham has already shown, and I can fully confirm his observations, that an experimental animal may die of *M. melitensis* infection at a period as far distant as three months from the date of inoculation.

My intention was rather to so raise the virulence of the coccus for the guinea-pig that a comparatively small, and accurately measurable dose, should consistently cause death within a definite period of seven days; and in tabulating my results I have been guided by this principle, and have restricted myself as far as possible to the inclusion of

* Eyre, "The Preparation of Nutrose Agar," 'Trans. Path. Soc.,' 55, 1904, p. 91.

those animals in any given series that succumbed within seven days to the smallest dose. For instance, Guinea-pig 12 was in fact labelled (B) of a series of three inoculations performed on the same day with different doses of the same culture. (A) received 25 loops, and died in 21 hours; (C) received 0·1 loop, and died in 12 days; therefore (B), having received the smallest dose (1 loop) that was fatal within the prescribed period, alone appears in the table.

From the details shown it will be seen that after 21 passages through guinea-pigs the virulence of a particular strain of *M. melitensis* originally so feeble that 75 loops (or 37·5 milligrammes) of culture required 25 days to kill a 380-gramme guinea-pig, has been so exalted that two loops (or 1 milligramme) of culture is sufficient to kill a 590-gramme pig in about 24 hours, whilst 0·5 loop (or 0·25 milligramme) will kill a 350-milligramme pig within five days.

Course of the Infection.

The course of the infection of the guinea-pig by *M. melitensis* may be conveniently considered under two separate headings: (1) Acute, and (2) Chronic, according to whether death is caused in a few hours or days, or is delayed for from one week to two or three months.

Acute Infection.—An animal dying within a few days of intracerebral inoculation with a moderate dose of a highly virulent cultivation or a large dose of a less virulent one, supplies the type for this form of *M. melitensis* infection.

A short incubation period varying in duration from 12 to 24 hours follows the inoculation, and during this time the animal appears to be in normal health and eats well, although the progressive loss of weight which is the marked characteristic of the infection begins within a few hours of inoculation. A stage of irritation follows the incubation period, and lasts for about 24 hours; it is marked by convulsions, at first localised and produced in response to direct stimuli; afterwards becoming generalised, tonic in character and occurring at frequent and irregular intervals; progressive muscular weakness is a marked feature of this stage, throughout which the animal is obviously ill and stupid, and refuses food. The stage of irritation passes gradually into one of coma, with paresis or paralysis, affecting first the hind legs, afterwards involving the fore limbs also. Handling or even touching will at first rouse the animal and provoke general convulsions; later, the guinea-pig falls on its side, becomes insensible, and, in fact, appears moribund. In this condition, however, the animal may remain for 24 or even 36 hours, and during the latter part of this period no rectal temperature can be recorded by the ordinary clinical thermometer, for 32° C. is hardly ever exceeded. Death is sometimes preceded by convulsions, but usually no such warning is given. To give a concrete

illustration of the train of symptoms and *post-mortem* findings in these acute infections I cannot do better than cite in full the clinical history of and autopsy on guinea-pig 19 (*vide* Table II), which is quite typical. Incidentally, I may mention that this case would serve equally well to illustrate the course of infection in the rabbit.

Guinea-pig 19. Sex ♂. Weight 450 grammes. Temp. 38° C.

11.2.05	4 P.M.	A.C.E. was administered, and a 6 mm. trephine circle was cut from left parietal bone. Four (4) loops of 3-day old agar cultivation of *M. melitensis* from spleen of Guinea-pig 18, emulsified in 0·2 c.c. sterile saline solution, injected into substance of left cerebral hemisphere. Disc of bone replaced, also periosteum, skin incision sutured, and wound dressed with collodion and cotton-wool.
	12 P.M.	Appears quite well. Has eaten well since inoculation.
12.2.05	9 A.M.	Is huddled up in one corner of cage; is not eating; hair dull and standing on end; is obviously ill. Has lost 60 grammes in weight.
13.2.05	"	Condition apparently unchanged. Has lost a further 60 grammes in weight.
	10.15 A.M.	Is now grinding teeth, moves slowly, and, if turned on back, rights itself very slowly.
	10.30 A.M.	Generalised spasms result if touched; convulsive movements occur from time to time even in the absence of obvious stimuli.
	1 P.M.	Much worse—marked paresis of hind quarters.
	2 P.M.	Convulsive "circus" movements occur from time to time—the animal dragging itself round "clockwise" by means of its fore paws.
	9 P.M.	Quiet in corner of cage; breathing laboured.
14.2.05	9 A.M.	Apparently unconscious, lying on side; if placed on legs is unable to stand, and falls down after slight feeble convulsive movements, once more becomes still. Breathing shallow and slow.
	11.30 A.M.	Condition unaltered.
	11.45 A.M.	Still in same position as when last looked at. Is now dead.

Post-mortem Examination.

Scalp Incision.—Scalp wound healthy in appearance, lips of incision healing by primary union; no signs of pus visible in wound; no stitch abscesses.

Subcutaneous tissue occupied by œdematous and jelly-like exudation marked here and there with small hæmorrhages.

Bone.—The disc of bone is firmly fixed *in situ* by serous exudation, in which the periosteum is also involved. On raising the disc of bone no protusion of meninges, etc., occurs.

Cranial Cavity.—(This is most conveniently reached without damage

to the structures beneath by reflecting skin and periosteum from over the entire cranial vault; then, with a red-hot iron, thoroughly searing the bone, which when seared and dry can easily be broken up with a pair of forceps, and removing it piece-meal, starting from the trephine circle.)

General congestion and injection of the vessels of the dura mater, the site of inoculatión being marked out by an area of bloody lymph, roughly corresponding in size and shape to the circle of bone removed from the calvarium. On removing the meninges a thick layer of yellowish lymph is seen adhering to the surface of the convolutions in the left parieto-occipital region (this microscopically consists of a dense mass of large mononuclear leucocytes, permeated throughout by masses of cocci); cerebral vessels greatly engorged and numerous petichial hæmorrhages visible on the surface of the brain.

The cerebro-spinal fluid is more or less increased in amount and contains numerous micrococci, free and also included in cells.

On section there are numerous small hæmorrhages scattered throughout the brain substance, whilst the *velum interpositum* is so congested as to resemble a clot of blood. Elsewhere the brain appears unaffected to the naked eye. Agar tubes inoculated with brain substance from any portion of cerebrum or cerebellum or from cerebro-spinal fluid, either cerebral or spinal, yield a copious and pure growth of *M. melitensis* within 36 hours.

Thoracic Cavity.—Slight enlargement of anterior mediastinal and of bronchial glands. Small quantity of clear serous effusion in the pleural cavity. Cultivations from this fluid remain sterile. Few hæmorrhages on the surface of lungs. Pericardium distended with clear serous fluid, also sterile. Blood removed from right side of heart plated in agar yields, on an average, some 35 colonies per cubic millimetre.

Peritoneal Cavity.—Excess of clear blood-stained fluid in peritoneal cavity, sterile on cultivation. Gall-bladder distended with clear bile. Liver, spleen, kidneys dark and engorged with blood, the spleen being distinctly enlarged.

Cultivations from liver and spleen give good growth of *M. melitensis* within 48 hours. Kidney pulp yields only a few scattered colonies of *M. melitensis.*

Omentum injected; a few enlarged mesenteric glands noted.

Bladder distended with turbid urine. Cultivations prepared from the centrifugalised deposit of the few cubic centimetres of urine contained in the bladder remain sterile.

Cultivations from the bone marrow from practically all the long bones yield a more luxuriant growth of *M. melitensis* than from other organs, with perhaps the exception of the spleen and brain.

Chronic Infection.—As in the present instance we are not particularly concerned with chronic infection, I shall dismiss this subject very briefly.

After intracerebral inoculation with a very minute dose of a highly virulent culture or a fair sized dose of a less pathogenic one the infection pursues an extremely chronic course, and beyond progressive emaciation and profound anæmia presents no very marked or characteristic symptoms. The early symptoms resemble those of the more acute infection above described but are much less severe in character. For instance the incubation period is usually prolonged to two or three days and is followed by a period, extending over from three to six days, during which the animal is distinctly ill and refuses its food, remains huddled up in one corner of its cage, loses weight rapidly and becomes extremely weak. Convulsions of a mild type can usually be provoked at the beginning of this stage by handling the animal or by turning it on to its back.

The animal then gradually recovers, eats well—even ravenously—and although the emaciation may be arrested for a while, the original weight is never entirely recovered. After an interval extending over weeks or even months, during which, except for emaciation, the animal appears in perfect health, death suddenly takes place.

More rarely the animal is obviously ill for two or three days before death, refuses food and becomes comatose just before the end.

Post-mortem Appearances.

Seat of Inoculation.—The site of the skin incision is occupied by a firm linear scar usually adherent to the periosteum and bone beneath, the disc of bone, if it has been replaced, has usually united completely.

Cranial Cavity.—Slight injection of meningeal and cerebral vessels usually present—brain substance appears normal.

Cultures from brain substance and cerebro-spinal fluid yield only a scanty growth of *M. melitensis* or remain sterile.

Thoracic Cavity.—Lungs usually anæmic, otherwise normal; cultures from heart blood remain sterile.

Peritoneal Cavity.—Peritoneum and intestines blanched and anæmic; no subperitoneal, omental or mesenteric fat visible; otherwise viscera normal. Cultivations from liver remain sterile; those from spleen and bone marrow may or may not yield a scanty growth; on the other hand those established from the centrifugalised deposit of the turbid urine or even from the urine itself give rise to fairly good growth.

Mode of Exit of M. melitensis *from the Body.*

A matter of the highest practical importance, but one upon which I have not yet touched, deals with the route or routes by which *M. melitensis* leaves the animal body. So far as concerns what we have termed "chronic" infections, *M. melitensis* can be readily isolated from catheter specimens of the urine throughout the course of the infection and also from urine taken directly from the bladder *post-*

mortem, even when intervals measured by months have elapsed since the inoculation, and no matter what the path of the original infection of the animal has been—intraperitoneal, subcutaneous, or intracranial. This was shown first by Durham, and his results, so far as concerns the guinea-pig and rabbit, have subsequently been as fully confirmed by the observations of other workers as by my own experiments; Horrocks and Shaw have recorded analogous results, too, from observations upon the human subject.

When, however, we consider the results of observations upon the *acute* infections, we find that *M. melitensis* is not consistently present in the urine. In about 50 per cent. of the animals dying within five days of inoculation, I have failed to detect the Micrococcus in the urine, although I have employed the entire contents of the bladder for the insemmination of culture tubes and plates.

During the experiments detailed above, which had for their primary object the exaltation of virulence, I systematically examined many of the organs of the infected animals by cultural tests, using a special circular loop of 1·5 mm. diameter, and carefully compared the amount of the resulting growths.

My observations soon convinced me that the most copious growth per loopful of material was obtained from the brain substance, next in order and all about equal came the liver, spleen, and long bone marrow. Finding such large numbers of cocci present in the liver tissue, I naturally turned my attention to the contents of the gall bladder.* In my first observations I seared the surface of the gall bladder with a red hot iron at some convenient spot, punctured the wall with a Pasteur pipette, and aspirated some of the bile in order to prepare my cultivations.

My results were unsatisfactory and inconsistent—sometimes a good growth of *M. melitensis* was obtained, at others the cultures remained sterile. My positive results, I noticed, were obtained when the cultures were made immediately after death; usually, when the *post-mortem* examination was not performed until some hours after death, a negative result was recorded.

It was next observed that if the cadaver was allowed to remain undisturbed, sedimentation occurred in the bile, and the cocci became collected into large flocculent masses deposited near the mouth of the common bile duct, so that if cultivations were made from the supernatant bile no growth resulted, although good growth could be obtained from the before-mentioned flocculent masses when these were taken up by the pipette in aspirating the last portion of bile.

Following the course of the bile, in my subsequent *post-mortem* examinations I prepared plate cultivations (using the modified Drigalaki and Conradi "nutrose" medium that I have already described in connection with some dysentery investigations) from

Table II.—Intracerebral Passages to Exalt Virulence.

Guinea-pig. No. in series.	Sex.	Weight in grammes.	Dose of inoculum.		Bulk of inoculum.	Duration of infection.	Weight at death, in grammes.	Observed loss of weight.	
			In loopfuls.	In milligrammes.				Total in grammes.	Percentage of body weight.
1	♂	380	75	37 ·5	0 ·4	25 days	160	220	78 ·5
2	♀	420	25	12 ·5	0 ·3	15 ,,	150	270	64 ·2
3	♂	460	25	12 ·5	0 ·2	7 ,,	250	210	45 ·6
4	♂	700	25	12 ·5	0 ·3	9 ,,	350	350	50
5	♀	750	25	12 ·5	0 ·2	2½ ,,	620	130	17 ·3
6	♀	480	25	12 ·5	0 ·2	2½ ,,			
7	♂	560	25	12 ·5	0 ·2	2 ,,			
8	♀	560	12	6	0 ·3	2 ,,	450	110	19 ·6
9	♂	890	12	6	0 ·3	3 ,,	710	180	20 ·2
10	♂	570	12	6	0 ·2	3½ ,,	460	110	19 ·3
11	♂	370	6	3	0 ·2	2 ,,	270	100	27
12	♂	310	1	0 ·5	0 ·2	4½ ,,	200	110	35 ·4
13	♂	240	12	6	0 ·2	2½ ,,	210	130	54 ·1
14	♂	240	15	7 ·5	0 ·2	4 ,,	210	130	54 ·1
15	♀	240	5	2 ·5	0 ·1	24 hours	200	40	16 ·6
16	♀	240	8	4	0 ·2	2 days	165	75	31 ·2
17	♂	180	6	3	0 ·2	2 ,,	150	30	16 ·6
18	♂	350	6	3	0 ·2	2½ ,,	320	30	8 ·5
19	♂	450	4	2	0 ·2	3 ,,	280	170	37 ·7
20	♀	250	*	*	*	21 hours	210	40	16
21	♀	380	2	1	0 ·1	3½ days	270	110	28 ·9
22	♀	590	2	1	0 ·3	24 hours	460	130	22
23	♂	350	0 ·5	0 ·25	0 ·1	5 days	230	120	34 ·2
24	♂	460	0 ·5	0 ·25	0 ·1	2 ,,	360	100	21 ·7
25	♀	430	0 ·5	0 ·25	0 ·1	3 ,,	320	110	25 ·5

* Owing to error, no note was made of the size of the dose.

Guinea-pig. No. in Series.	Brain substance.	Heart blood.	Serous effusion in thorax.	Spleen.	Liver.	Bile.	Peritoneal fluid.	Kidney.	Urine.	Long bone marrow.	Duodenum.	Jejunum.	Ilium.	Cæcum.	Rectum.	Fæces.	Intestinal mucus.
	Micrococcus melitensis recovered in culture from—																
1	±	−		±				±	+								
2	+	−		±				±	+								
3	+	±		+				+	+								
4	+	+		+				+	+								
5	+	+		+				+	+	+							
6				+				−	+	+							
7	+	−		+				−	−	+							
8	+	+		+	+			+	+	+							
9	+	+	−	+	+			+	−	+							
10	−	+		+	+			−	−	+							
11	+	+		+	+	+		±	−	+							
12	+	+		+	+	+	−	+	−	+							
13	+	+		+	+	+		+	−	+							
14	+	+		+	+	−		+	−	+							
15	+	+		+	+	+		+	−	+							
16	+	+		+	+	−		0	0	0	+						
17	+	+		+	+	+		0	0	0	+	−	−	−	−	−	−
18	+	+		+	+	−		0	0	0	+	+	−	−	±	−	0
19	+	+	−	+	+	+	−	±	−	+	+	+	+	−	0	±	0
20	+	+		+	+	+		+	−	0	+	+	+	+	+	0	+
21	+	+		+	+	+		+	+	0	+	0	+	0	0	+	+
22	+	+		0	+	+		−	−	0	+	0	0	0	+	+	0
23	+	+		+	+	+		±	+	0	+	0	0	0	0	±	0
24	+	+		+	0	±		−	−					+	0	+	+
25	+	+		+	+	+		−	−					+			

+ = growth of *M. melitensis*. ± = scanty growth of *M. melitensis*. − = no growth of *M. melitensis*. 0 = not examined.

scrapings from the walls of the bile duct, and from the mucous membrane lining of the duodenum, and had no difficuly in demonstrating the presence of fair numbers of the Micrococci in both these situations. Proceeding onwards along the intestinal canal, positive results were obtained from the upper portions of the jejunum, but owing to the enormous numbers of purely intestinal bacteria which rapidly overgrew the plates, I was at first unable to demonstrate *M. melitensis* in the lower portion of the jejunum, the ileum, cæcum or rectum.

With the death, however, of Guinea-pig 20 (*vide* Table II) within 24 hours of inoculation, a positive result was obtained from each of these situations, although as the rectum was empty no observations could be carried out with regard to the characteristic fæcal masses.

Guinea-pig 21 (*vide* Table II) was deposited in a sterilised glass dish whilst in a moribund condition, so that when the contents of the rectum were expelled at death an hour later, it became a simple matter to prepare plate cultivations from intestinal mucus and fæces separately.

From the mucus a fair number of Micrococci was isolated; the fæcal masses gave considerably more trouble on account of the numerous members of the coli and streptococcus groups that were present, but eventually several colonies were isolated and completely identified with *M. melitensis.*

As will be seen from the details of the *post-mortem* examinations (Table III), these results were confirmed more than once.

From the results of these experiments, therefore, the assumption is justified that *M. melitensis* leaves the body of experimental animals by way of the intestinal tract, and possibly by way of the urinary tract also, when the infection is of the acute type. That the coccus leaves the body by way of the urinary tract *alone* when the infection is of a more chronic character appears probable also, for not only have I not succeeded in isolating it from the alimentary canal or fæces of such animals, but cultivations from liver and bile have always yielded negative results.

Conclusions.

1. By a series of intracerebral inoculations, comprising rapid passages from guinea-pig to guinea-pig, the virulence of *M. melitensis* can be exalted to a high pitch for this particular animal.

2. The virulence finally obtained in the present series is such that a small and accurately measurable dose of cultivation corresponding to about 0·25 milligramme in weight, or to rather more than 6,000,000 cocci, will consistently cause death in about five days.

3. Experimental observations show that in these acute infections *M. melitensis* leaves the body of the inoculated animal by way of the alimentary canal, in the intestinal mucus and the fæces, as well as occasionally by way of the urinary tract (in the urine).

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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART III.

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AUGUST, 1905.

CONTENTS.

INTRODUCTION.

In the Introduction to Part I, the history of this investigation into the causation and prevention of Mediterranean Fever was given from its commencement until the end of the summer of 1904.

Major W. H. Horrocks, R.A.M.C., and Dr. R. W. Johnstone, Local Government Board, left Malta at the end of September and arrived in England on October 8, 1904.

The results of the work of the Commission during the summer of 1904 are published in Parts I and II.

At a meeting of the Sub-Committee, held on November 17, 1904, it was decided that Staff-Surgeon E. A. Shaw, R.N., Dr. T. Zammit, Board of Health, Malta, and Captain J. Crawford Kennedy, R.A.M.C., should continue the work during the coming winter, and that Major Horrocks and Dr. Johnstone be asked to return to Malta at the beginning of the following fever season. As Captain Kennedy had been struck off all military duty and was devoting his whole time to the work of the investigation, he was made a member of the Commission.

Major Horrocks returned to Malta about the end of May, 1905, but Dr. Johnstone was unable to take up the work again this summer. Lieut.-Colonel A. M. Davies, R.A.M.C., was therefore appointed a member of the Commission in his place and arrived in Malta on May 28, 1905.

Colonel Bruce, C.B., F.R.S., R.A.M.C., the Chairman of the Sub-Committee, left England on May 19, 1905, and proceeded to Malta, where he met the members of the Commission. Staff-Surgeon Shaw and Captain Kennedy handed to him the papers which form part of the present volume. Dr. Zammit informed him that on account of the pressure of other duties he had been able to do but little work for the Commission, but that he would now be able to devote his whole time to it. He communicated some notes on the feeding of goats with *Micrococcus melitensis*, which seemed to show that the goat is to some extent susceptible to Mediterranean Fever. The following experiments were made by Dr. Zammit:—

Experiment 1.—*White Goat.*

To note the effect of feeding goats on material containing *Micrococcus melitensis.*

1904—

Sept. 15. Examined blood for agglutination. Negative.

„ 18. Fed this goat, adding the contents of a culture of *M. melitensis* on agar to its food.

Dec. 3. Blood has reacted in dilutions of 1 in 20 to 1 in 100, but the temperature curve shows no rise. Fed again in the same way.

„ 23. Blood reacts 1 in 300.

1905—
Apr. 29. Blood reacts 1 in 100. Goat still alive.

Experiment 2.—Red Goat.

1904—
Dec. 3. No blood reaction. Fed one tube agar.
" 5. Fed again.
" 15. No blood reaction.
" 23. Blood reacts 1 in 20; 1 in 50 after half-an-hour.

1905—
Apr. 29. Blood reacts 1 in 50.

Dr. Zammit informed the Chairman that he considered goats to be susceptible to Mediterranean Fever, and that the disease is spread to human beings by goats. A temporary laboratory was set up in the Lazaretto buildings, Fort Manoel, to continue the investigation of the disease in goats and also the transference of the disease by mosquitoes.

Colonel Bruce returned to England on June 12, 1905.

On June 23, 1905, Major Horrocks wrote that he had discovered the *M. melitensis* in the milk of an apparently healthy goat, and on the 26th he further wrote that he had already found the *M. melitensis* in the milk of five goats taken from two different herds, and that Dr. Zammit had found it in the blood of one of these goats. Horrocks also said that the milk of the goat fed by Dr. Zammit last September was still crammed with *M. melitensis*. It would therefore appear that the Commission are on the eve of an important and may be far-reaching discovery.

On July 18, 1905, the Chairman received preliminary notes from Major Horrocks, Captain Kennedy, and Dr. Zammit, on the propagation of Malta Fever by means of goats. These are added to the present volume.

These notes show (1) that one or more apparently healthy goats in every herd are excreting *M. melitensis* in their milk and urine; (2) that about 50 per cent. of the goats in Malta react to Mediterranean Fever when examined by the serum agglutination test.

It may be objected that no exact proof exists that the drinking of milk containing *M. melitensis* will give rise to the disease in man. When we take, however, into consideration the results of the feeding and inoculation experiments on monkeys, it may be assumed with safety that the disease is propagated in this way, and that no time should be lost in removing such a grave and insidious danger to the public health.

I. ON A QUANTITATIVE BACTERIOLOGICAL EXAMINATION OF THE BLOOD OF 103 MEDITERRANEAN FEVER PATIENTS.

By Staff-Surgeon E. A. SHAW, R.N., Member Mediterranean Fever Commission, Malta.

Blood.

In my September Report I gave the results of the examination of the peripheral blood of 51 Malta Fever patients for the *Micrococcus melitensis* (hereafter referred to as *M. melitensis*). I now give briefly the results of a further series of 52 such cases similarly examined, making a total of 103 cases examined. If any points seem inadequately explained a reference to the first Report will elucidate matters.

Method.—Bend of elbow prepared as for a surgical operation, carbolic acid being the disinfectant used, a pad of lint soaked in 1 in 20 of this being kept on site of intended puncture till the latter was made. Five c.c. of blood drawn off from median basilic vein in graduated sterile serum syringe; 3 c.c. of this placed in a flask containing 60 c.c. of peptone broth, 1 c.c. into a tube containing 19 c.c. of peptone broth and 1 c.c. into a second tube also containing 19 c.c. of broth, and all these well shaken. The flask containing 3 c.c. of blood and one of the tubes containing 1 c.c. of blood were incubated intact. The second tube containing a mixture of 19 c.c. of broth and 1 c.c. of blood was treated as follows: half of its contents were removed with a 10 c.c. sterile pipette and it was then put aside, now containing $\frac{1}{2}$ c.c. of blood and $9\frac{1}{2}$ c.c. of broth, to be incubated; the contents of the 10 c.c. pipette were then added to a 10 c.c. broth-tube, which was well shaken, and now contained 20 c.c. of fluid, $\frac{1}{2}$ c.c. of which was blood; 10 c.c. of this mixture was removed with the 10 c.c. pipette, leaving it containing $\frac{1}{4}$ c.c. of blood, and it was put aside to be incubated; the contents of the pipette were added to another 10 c.c. broth-tube, which in its turn was left with $\frac{1}{8}$ c.c. of blood, and so on, halving the quantity of blood each time till the following series was obtained: flask containing 3 c.c. of blood, tubes containing 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{128}$, $\frac{1}{256}$, and $\frac{1}{512}$ c.c. blood duly numbered and dated, these were then placed in the incubator at 37°, being taken out daily and well shaken to facilitate distribution of the possible *M. melitensis* throughout the medium. At the end of a week glucose-litmus-agar slopes were inoculated by means of a loop from

the 3 c.c. flask, 1, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, and $\frac{1}{16}$ c.c. tubes, these duly labelled and all returned to the incubator. At the expiration of another two days these slopes were examined and those which exhibited growth were put aside to be put through the usual tests for *M. melitensis* (see September Report), and the others with the original broth-tubes returned to the incubator. At the end of a second period of two days the agar slopes were again examined, those showing growth being dealt with as before, and now, it being 11 days since commencement of incubation, those slopes which showed no growth were reinoculated plentifully from the corresponding broth-tubes, and the remainder of the series, the $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{128}$, $\frac{1}{256}$, and $\frac{1}{512}$ c.c. blood broth-tubes, were sub-cultured by means of a large platinum loop on to agar slopes, and all returned to the incubator for a further period of three days, after which all slopes were examined for growth, results recorded, and the examination of that particular specimen of blood terminated.

The foregoing was the general method adopted. It was only slightly departed from in the last 25 cases; in which in order to determine the earliest date at which in these examinations *M. melitensis* made its appearance in the broth, daily sub-cultures were made from the flask containing the 3 c.c. of blood starting from the first day of incubation. As this was never found to be later than the eighth day, and as it will be observed from the foregoing that a total of eleven days' incubation in broth, the same period as observed in the first series of 51 cases, was completed before a blood broth-tube was abandoned as unfruitful, there is obviously an ample margin of safety, and I do not consider that there was any possibility of any fruitful blood broth-tube having been overlooked.

The following table gives the result in a very compressed form; it seems to me unnecessary to write out each blood examination separately. In the remarks which follow the tables, such cases as call for it are discussed in greater detail individually. As all the cases in this series were English and male, nine patients belonging to the navy, and 43 to the army, no column descriptive of nationality and sex has been necessary. In the column "stage of fever," the word "wave" refers to waves of raised temperature. In the column giving patients' temperature for a few days prior to bleeding, the last temperatures are those for the morning and evening of the day blood was drawn, those preceding it being arranged in regular chronological order; the intention being by comparing these, in the cases yielding *M. melitensis*, to ascertain if any relation existed between course of temperature and presence of *M. melitensis* in the blood; these temperatures are given in the form of a fraction, the numerator being the morning and the denominator the evening temperature, the one taken about 8 A.M. the other about 5 P.M. Day of disease, as before, has been calculated from the day the patient first began to feel ill, not from date of

admission into hospital. In each case the highest dilution of the patient's blood serum (determined from a portion of the blood taken for bacteriological examination), which gave a distinct agglutination reaction in a quarter of an hour under the $\frac{2}{3}$-in. objective of the microscope, has been worked out and is given in the appropriate column as a dilution of 1 in ..., the unit being serum, the other numeral being so many equivalent bulks of "normal" physiological salt solution.

In the last column "recovery of and smallest quantity of blood yielding *M. melitensis*," "Nil" signifies that in this case the result of the examination was negative. The minimal quantity of blood yielding *M. melitensis* is given as in decimals of a cubic centimetre, a preference having been expressed for this mode of presenting it. To facilitate comparison with the first series in which this quantity was expressed as a fraction, I give the equivalent from $\frac{1}{8}$ onwards—

$\frac{1}{8}$ c.c. = 0·1250 c.c. $\frac{1}{16}$ c.c. = 0·0625 c.c. $\frac{1}{32}$ c.c. = 0·0312 c.c.
$\frac{1}{64}$ c.c. = 0·0156 c.c. $\frac{1}{128}$ c.c. = 0·0078 c.c.
$\frac{1}{256}$ c.c. = 0·0039 c.c. $\frac{1}{512}$ c.c. = 0·0019 c.c.

In the chronological table which comes immediately after the foregoing, fractions have had to be resorted to, because when, as in the 17th and 22nd days of the disease, the results of as many as six blood examinations had to be put down in one space, the use of decimals was found to result in an agglomeration of figures in which "definition" was greatly lacking. Here also the foregoing equivalents may be found useful.

No. of case.	Age.	Stage of the fever.	Temperature of patient for few days preceding bleeding.	Day of disease.	Time of bleeding and patient's temperature.	Maximum dilution of patient's blood giving agglutination.	Recovery of and smallest quantity of blood yielding *M. melitensis*.
			° F.				c.c.
52	21	Nearing end of 1st wave	99·4/101·6, 98·6/100, 98·4/98·6, 100/98·6, 98·4/98·4 ……………	35th	10.40 A.M., 98°·6	1 in 200	0·5
53	20	Middle of 1st wave	98·0/98·6, 98·2/99·4, 100/102, 99·6/100·2, 98·6/100·8 …………	19th	10.55 A.M., 99°·2	1 in 500	0·125
54	20	Middle of 1st wave	100·6/102·2, 101·4/102·6, 101/102, 99/101, 98·4/100·8 ……………	23rd	11.5 A.M., 99°4	1 in 2500	Nil
55	24	Still in 1st wave …	98·8/100, 98·6/100, 98·8/100·4, 98·8/99·8, 98·8/100·4 ……………	33rd	10.50 A.M., 99°	1 in 200	0·25
56	35	In 2nd wave………	98·2/100·6, 98·6/101·6, 99·2/102·2, 100·4/102·8, 100·8/103 ………	116th	11.0 A.M., 101°	1 in 500	Nil
57	19	Middle of 2nd wave	100·2/102·8, 100·4/102·6, 100·4/102, 101·4/102·4, 101/102·4 ………	96th	11.10 A.M., 101°·2	1 in 2000	0·25
58	24	In 1st wave ………	101·6/100·2, 100·6/100·8, 100·6/101·2, 100/101, 99·6/102 ……………	17th	10.50 A.M., 100°·4	1 in 100	0·0312
59	22	In 2nd wave………	99·2/102, 99·6/103·6, 101·6/103·2, 99·6/103·4, 99·2/102·8 ……………	51st	11.5 A.M., 100°·6	1 in 1000	2·00
60	29	In 2nd wave………	101·4/102·6, 100·4/101·2, 100/100·6, 100/101·8, 99·8/100·6 ………	70th	11.0 A.M., 100°·4	1 in 500	0·0312
61	21	In 1st wave ………	101·8/103, 99·4/100, 98·6/98·6, 98·4/98·2, 98/98·2 ……………	9th	11.10 A.M., 98°·6	1 in 2000	Nil
62	27	In 3rd wave ………	98/98·4, 98·2/100, 98·4/99·6, 98·4/99, 98·4/98·8 ……………	90th	10.45 A.M., 98°·6	1 in 500	0·0078

63	22	In 1st wave	98·4/100, 98·2/99·2, 98·4/98·2, 98·6/98·6, 98·2/99	40th	11.0 A.M., 98°·4	1 in 500	1·00
64	20	1st wave not yet ended	100/102, 97·8/101, 98·4/102, 97·8/100·8, 98·4/101	108th	11.10. A.M., 100°	1 in 40	Nil
65	20	In 1st wave	101·6/104·2, 103/104, 100·2/103·6, 99·2/100·4, 98·4/100·6	16th	11.10 A.M., 100°·2	1 in 40	Nil
66	28	Still in 1st wave ...	101·4/102·8, 100·4/104, 101·4/103·6, 101·6/104·2, 101·6/103	65th	11.15 A.M., 102°	1 in 500	0·0078
67	20	In 1st wave	98·4/100·4, 99·4/100·6, 99/100, 98·8/98, 98/100·2	22nd	11.10 A.M., 99°	1 in 1000	0·125
68	28	Had 2 waves in 1st attack, then out of hospital 31 days, now in 1st wave of relapse	98/100·8, 98·6/100·2, 99·4/100, 100·6/102, 98/101·8	116th	11.25 A.M., 98°·6	1 in 500	Nil
69	23	In 1st wave	100·6/104, 101·2/103·4, 99·6/102, 98·2/99·8, 98·2/100	27th	11.15 A.M., 99°	1 in 20	Nil
70	41	In 1st wave of a relapse	98·6/99, 98·2/99, 98·2/99·6, 98·6/100, 98·6/100·2	158th	11.30 A.M., 99°	1 in 40	0·25
71	20	Still in 1st wave ...	102/104, 101·2/103, 102/103·4, 101·6/103·6, 101 2/102·6	56th	12.15 A.M., 102°	1 in 500	0·5
72	21	In 1st wave	98·4/100·8, 99·4/101·6, 100·2/101, 99·2/100·4, 99·2/100·6	17th	11.20 A.M., 99°·8	1 in 1500	0·0625
73	27	In 1st wave	99·6/101·6, 99·6/102·4, 100·4/102·2, 101/102·8, 100·4/102·6	22nd	11.30 A.M., 101°	1 in 2000	0·5
74	25	In 1st wave	101/103·2, 100·6/103·6, 101·2/103·4, 100·4/103·4, 101·2/103	18th	11.45 A.M., 102°·1	1 in 2000	0·5
75	24	In 3rd wave	98·6/100, 98·4/100, 98·6/100·2, 98·2/99·8, 100/103·3	149th	4.45 P.M., 103° 3	1 in 1200	Nil
76	20	In 3rd wave	98·4/101·2, 98·8/100, 98·4/101·2, 99·2/100·6, 98·5/102·5	120th	5.0 P.M., 102°·5	1 in 800	0·0625
77	21	In 3rd wave	98·4/100·8, 98/102·4, 98·6/102, 98·6/101, 98·4/99	151st	5.10 P.M., 99°	1 in 300	1·00

No. of case.	Age.	Stage of the fever.	Temperature of patient for few days preceding bleeding.	Day of disease.	Time of bleeding and patient's temperature.	Maximum dilution of patient's blood giving agglutination.	Recovery of and smallest quantity of blood yielding *M. melitensis*.
			° F.				c.c.
78	29	In 1st wave	98·4/102·2, 98·4/102·6, 98/101·6, 98·4/103·4, 99·4/103·6	35th	10.45 A.M., 100°	1 in 2600	1·00
79	20	In 1st wave	98·2/99·6, 97·8/101, 98·4/100·6, 98/100, 97·6/100·4	18th	11.0 A.M., 98°·4	1 in 3000	0·125
80	22	In 1st wave	98·4/97·6, 98·4/97·4, 98/98, 97·4/98·4, 97·4/99	17th	11.10 A.M., 98°	1 in 2500	0·5
81	24	In 1st wave	100·2/101, 98·4/102·4, 99/99·2, 99/100, 99/100·2	12th	4.40 P.M., 100°·2	1 in 500	Nil
82	27	In 2nd wave.........	99/102, 99·6/101, 98·4/101, 99·8/102·2, 99·2/101·6	67th	4.55 P.M., 101°·6	1 in 1500	1·00
83	37	In 1st wave	100·6/102·4, 99·4/101·6, 100·4/100·6, 99/100·4, 97·8/100	18th	5.10 P.M., 100°	1 in 3000	0·5
84	22	In 1st wave	98·2/99·4, 98·4/100·4, 98·4/101, 98·4/101·6, 98·4/101·5	16th	5.0 P.M., 101°·5	1 in 2000	5·0
85	21	In 4th wave	99/101, 99·4/101·2, 99·4/100, 99/101, 98·6/102	118th	5.10 P.M., 102°	1 in 1500	0·25
86	26	In 1st wave of a relapse after normal T interval of 6 weeks	99·2/102, 99·4/101·4, 99·4/101, 99·6/102·4, 100·4/103·2	153rd	5.20 P.M., 103°·2	1 in 1600	3·00
87	23	In 1st wave	N./N., 97/N., N./101, 100·2/N., N./97·4	12th	10.45 A.M., normal	1 in 200	Nil

88	21	In 1st wave	101/102, 101·4/100·6, 100·4/101, 100·2/100·4, 100·2/101·6	23rd	11.5 A.M., 100°·4	1 in 500	0·0312
89	32	In 1st wave	100·2/101·8, 101/101·6, 100·4/102·2, 100·8/101·2, 100/101·6	21st	11.15 A.M., 100° 8	1 in 40	Nil
90	19	In 2nd wave.........	98·8/102·4, 98·2/101·6, 98·2/102, 98·6/101·2, 98·4/100·2	43rd	4.45 P.M., 100°·2	1 in 3000	5·00
91	42	In 2nd wave.........	99·4/100·8, 98·2/100·6, 99·4/102, 98/99·6, 98·4/99·8	62nd	5.0 P.M., 99°·8	1 in 500	Nil
92	22	In 1st wave	99/101·4, 100/101, 99·8/101·4, 100/101·2, 100·6/99·8	41st	5.15 P.M., 99°8	1 in 1200	0·0156
93	20	In 1st wave	100·2/101·8, 99·4/103, 101/102·8, 101·6/101·4, 101/103	21st	4.0 P.M., 103°	1 in 2000	1·00
94	29	In 1st wave	100/102·8, 101·4/103, 100/102·4, 100/101·6, 100·8/102·8	31st	4.15 P.M., 102°·8	1 in 2500	1·00
95	35	In 1st wave	100/98, 100·4/102, 99/101·2, 99·2/100·2, 97·2/100·4	21st	4.30 P.M., 100°·4	1 in 3000	0·0625
96	36	In 1st wave	99·8/101, 100/99·6, 100/102·4, 100·2/102, 101·4/103	19th	4.45 P.M., 103°	1 in 2500	0·0312
97	24	In 1st wave	102·4/102·2, 98·2/98·4, 97·2/98, 97·8/97·8, 98/97·8	26th	4.0 P.M., 97°·8	?	Nil
98	31	In 1st wave	102·4/103, 102·2/102·6, 100·4/103, 102·2/102·4, 101·2/103·2	21st	4.15 P.M., 103°·2	1 in 2500	0·0312
99	19	In 4th wave	98/100·2, 99·4/101·8, 98·6/101·8, 98·6/100·2, 98·6/100·2	66th	4.30 P.M., 100°·2	1 in 1000	0·0312
100	25	In 1st wave	99·8/102·2, 99·2/102·4, 99/102·2, 100·2/102·5, 101·2/103·5	25th	4.45 P.M., 103·5	1 in 1500	0·5
101	25	In 1st wave	99·2/101·6, 98·6/101, 99·4/102, 99·2/102·6, 100/102	32nd	4.15 P.M., 102°	1 in 2400	0·25
102	30	In 1st wave	100·4/102·8, 101·2/102·8, 100/101·8, 99·6/101·4, 98·8/100	22nd	4.30 P.M., 100°	1 in 2000	0·0625
103	26	In 1st wave	100·4/102·2, 100 2/101·6, 99·6/101·8, 99/101·6, 101/103	17th	4.45 P.M., 103°	1 in 2200	1·00

Examination of Bloods.

Table showing in chronological order the date of the disease in each of the 103 cases in which blood was taken for bacteriological examination and the result. The word "Nil" means no *M. melitensis* was recovered; the days of disease not represented by a blood examination are shown blank. It will be seen that while many days are blank, others are represented by two to six blood examinations. As stated before, this has been unavoidable; the number of cases willing to submit to venous puncture was too small to admit of selection. The minimal amounts of blood yielding *M. melitensis* in each case are expressed in fractions of a cubic centimetre.

Day of disease.	Recovery and quantity or no recovery.	Day of disease.	Recovery and quantity or no recovery.	Day of disease.	Recovery and quantity or no recovery.
1		37	$\frac{7}{8}$ c.c.	75	
2		38		76	
3		39		77	
4		40	1 c.c.	78	
5		41	Nil, $\frac{1}{16}$, $\frac{1}{64}$ c.c.	79	
6		42	$\frac{1}{128}$ c.c.	80	
7	$\frac{1}{8}$, $\frac{1}{128}$ c.c.	43	5 c.c.	81	
8	$\frac{1}{64}$ c.c.	44		82	
9	Nil, $\frac{1}{9}$, $\frac{1}{8}$, Nil.	45		83	
10	$\frac{1}{9}$, 1 c.c.	46		84	
11	$\frac{3}{4}$ c.c.	47		85	
12	1, Nil, Nil.	48	Nil.	86	
13	Nil.	49	$\frac{9}{10}$ c.c.	87	
14		50		88	
15	Nil, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{256}$ c.c.	51	2 c.c.	89	
16	Nil, 5 c.c.	52		90	$\frac{1}{128}$ c.c.
17	Nil, Nil, $\frac{1}{32}$, $\frac{1}{16}$, $\frac{1}{2}$, 1 c.c.	53		91	
18	Nil, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{2}$ c.c.	54		92	
19	$\frac{1}{8}$, $\frac{1}{32}$ c.c.	55	$\frac{1}{64}$, $\frac{1}{64}$ c.c.	93	
20		56	$\frac{1}{4}$, $\frac{1}{2}$ c.c.	94	
21	Nil, 1, $\frac{1}{16}$, $\frac{1}{32}$ c.c.	57	Nil.	95	$\frac{1}{9}$ c.c.
22	Nil, Nil, 1, $\frac{1}{8}$, $\frac{1}{2}$, $\frac{1}{16}$ c.c.	58		96	$\frac{1}{4}$ c.c.
23	Nil, $\frac{1}{32}$ c.c.	59		97	
24		60		98	$\frac{1}{2}$ c.c.
25	$\frac{1}{256}$, $\frac{1}{2}$ c.c.	61		101	Nil.
26	$\frac{1}{16}$, Nil.	62	Nil.	108	Nil, Nil.
27	Nil.	63		109	
28	Nil, Nil.	64		110	
29		65	$\frac{1}{128}$ c.c.	116	Nil, Nil.
30	Nil, $\frac{9}{10}$ c.c.	66	$\frac{1}{32}$ c.c.	118	$\frac{1}{4}$ c.c.
31	Nil, $\frac{1}{8}$, 1 c.c.	67	1 c.c.	120	$\frac{1}{16}$ c.c.
32	Nil, $\frac{1}{4}$ c.c.	68		149	Nil.
33	$\frac{1}{4}$ c.c.	69	Nil.	151	1 c.c.
34	$\frac{1}{4}$ c.c.	70	$\frac{1}{32}$ c.c.	153	3 c.c.
35	$\frac{1}{2}$, 1 c.c.	71		158	$\frac{1}{4}$ c.c.
36	1, $\frac{1}{64}$ c.c.	72		240	Nil.
		73			
		74	Nil.		

Remarks.—It will be seen from an inspection of the foregoing tables that at any period of this fever up to the commencement of the 6th month of it (158th day) the causal micro-organism may be found in the blood, and in as small a quantity of blood in the course of the 3rd month as in the 1st month.

The smallest quantity of blood from which in this series of 103 observations it has been isolated has been $\frac{1}{256}$ c.c., practically 4 cub. mm., and that only in two cases.

It is unsafe to assume, as one investigator has done, that in any given case the smallest quantity of blood yielding *M. melitensis* contained only one micrococcus. It would be inexact to express the fact that $\frac{1}{256}$ of a c.c. of blood is the smallest quantity of blood yielding *M. melitensis* in a particular case, in the form that this blood contained 256 micrococci per c.c., and equally inexact to state the fact that 0·1 c.c. of blood incubated in 10 c.c. of broth yielded 31 colonies of *M. melitensis* on an agar slope, in the form that this blood contained 310 micrococci per c.c.; or that 0·25 c.c. of blood spread on the surface of an agar in a Petri dish and incubated, yielded 30 colonies of *M. melitensis* as 120 micrococci per c.c. We do not know whether this micrococcus in the blood is free in the plasma, is phagocyted inside a white blood corpuscle, or is present in both these conditions. If inside a leucocyte, we have yet to learn in what period of time the leucocyte can destroy the vitality of the micrococcus. In various experiments made to ascertain the phagocytic power of fresh normal blood on *M. melitensis*, I have frequently seen as many as 20 and 30 micrococci inside one leucocyte, and it is highly improbable that in combining blood with a nutrient medium, the leucocytes are completely fragmented, and any micrococci they may contain evenly distributed through the medium. For these reasons the somewhat cumbrous method of expressing results as minimal quantity of blood yielding *M. melitensis* has been adhered to as having at least the merit of accuracy.

Minimal Quantity of Blood Yielding M. melitensis.

It will be noticed that the minimal quantity of blood necessary to yield *M. melitensis* in these cases varies within very wide limits, from $\frac{1}{256}$ c.c. (Cases 43 and 47) to 5 c.c. (Cases 84 and 90), that is from approximately 4 cub. mm. to 5000 cub. mm. This surely was to be expected; why should it be constant in a series of patients any more than their agglutinating power on *M. melitensis*, which varies from nil to $\frac{1}{3500}$ or $\frac{1}{6000}$; or, indeed, any other clinical phenomenon?

Here seems the most appropriate place to discuss a feature I made mention of in my former report under the name of "skipping"; where *M. melitensis* was found in some of the higher blood dilutions, and absent from some of the lower, these having been "skipped" or "jumped." This occurred in two of the first series of 51 cases, and in

five of the second series of 52 cases. In Case 59 it was recovered only from the broth-tube containing $\frac{1}{16}$ c.c. of blood, all the other tubes remained sterile; excepting the flask containing 3 c.c. of blood here as a total of 2 c.c. of blood was incubated, obviously this had to be reported as a recovery of *M. melitensis* from 2 c.c. In Case 63 *M. melitensis* was recovered only from the 1 c.c. and the $\frac{1}{16}$ c.c. tubes, the others remaining sterile; it is reported as a recovery from 1 c.c. In Case 77 *M. melitensis* was found only in 3 c.c., 1 c.c., and $\frac{1}{16}$ c.c. tubes; it is reported as a recovery from 1 c.c. In Case 84, *M. melitensis* was found only in the $\frac{1}{4}$ c.c. tube, the 3 c.c., 1 c.c., $\frac{1}{2}$ and $\frac{1}{8}$ to $\frac{1}{512}$ c.c. tubes remaining sterile; it is reported as a recovery from 5 c.c. In Case 90, *M. melitensis* was found only in the $\frac{1}{4}$ c.c. tube, the others, 3 c.c. to $\frac{1}{512}$ c.c., remaining sterile; it is reported as a recovery also from 5 c.c.

This phenomenon must, I think, be interpreted as resulting from the small quantity of *M. melitensis* in the circulating blood; in these cases it would seem there was not enough to supply the tubes found sterile, and it would be a matter of chance into which tube the small apparently indivisible amount of *M. melitensis* got.

In no case has the minimal quantity of blood experimented with, $\frac{1}{512}$ c.c. (about 2 cub. mm.) ever yielded *M. melitensis*; in only two cases out of the 103 has the minimal quantity of blood been so small as $\frac{1}{256}$ c.c. (4 cub. mm.). This has a most important bearing on the question of the possibility of the transmission of infection by biting insects such as mosquitoes, which is still *sub judice*.

It is a larger quantity of blood than any biting insect to be found in Malta can contain. Again, with the possible exception of plague, no known bacterial disease has yet been proved to be thus conveyed; this mode of conveyance of infection would appear to be confined to protozoal diseases, and Schandinn's recent work on blood parasites,* in which he demonstrates that in the gnat the "indifferent" spirochætes are so small as only to be visible when a number have agglomerated, and that they can pass through a Chamberland filter, tends to place yellow fever, hitherto considered doubtful in this regard, amongst the protozoal diseases.

Is there any Relation between Temperature of the Patient and the Presence of M. melitensis *in his Blood?*

Taking first the temperatures for the few days preceding and including the date of the abstraction of blood, and grouping these in a tabular form together with the results of the blood examinations, we get the following table:—

* "Generations und Wirtswechsel bei Trypanosoma und Spirochæte," 'Arbeiten aus dem Kaiserlichen Gesundheitsamte,' Band 20, Heft 3, 1904.

Course of patient's temperature.	No. of cases.	No recovery of *M. melitensis.*	Recovery of *M. melitensis.*	Minimal quantities of blood yielding *M. melitensis* where recovered.
				c.c.
Steady between— 98° and 101°	20	7	13	$1, \frac{9}{10}, \frac{7}{8}, \frac{1}{4}, \frac{1}{8}, \frac{1}{8}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}, \frac{1}{64}, \frac{1}{128}, \frac{1}{256}$
99° and 102°	22	8	14	$1, 1, \frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{9}, \frac{1}{9}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}, \frac{1}{32}, \frac{1}{32}, \frac{1}{64}$
100° and 103°	20	4	16	$3, 2, 1, 1, 1, 1, \frac{1}{2}, \frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{1}{4}, \frac{1}{6}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}$
101° and 104°	12	3	9	$\frac{1}{2}, \frac{1}{8}, \frac{1}{9}, \frac{1}{16}, \frac{1}{64}, \frac{1}{128}, \frac{1}{128}, \frac{1}{128}, \frac{1}{256}$
102° and 105°	1	—	1	$\frac{3}{4}$
Ascending	7	1	6	$5, 1, 1, \frac{1}{4}, \frac{1}{2}, \frac{1}{32}$
Descending	14	6	8	$5, 1, \frac{9}{10}, \frac{1}{2}, \frac{1}{2}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}$
Steady about normal	7	5	2	$\frac{1}{2}, \frac{1}{2}$
Total cases ...	103	34	69	

Next grouping the cases according to the patient's temperature at the time blood was abstracted, we get :—

Patient's temperature.	No. of cases.	No recovery of *M. melitensis.*	Recovery of *M. melitensis.*	Minimal quantities of blood yielding *M. melitensis* where recovered.
				c.c.
97° to 97°·9...	1	1		
98° to 98°·9...	20	10	10	$1, \frac{9}{10}, \frac{9}{10}, \frac{1}{2}, \frac{1}{2}, \frac{1}{2}, \frac{1}{8}, \frac{1}{8}, \frac{1}{8}, \frac{1}{128}$
99° to 99°·9...	21	9	12	$1, 1, \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{9}, \frac{1}{16}, \frac{1}{16}, \frac{1}{64}, \frac{1}{64}, \frac{1}{64}, \frac{1}{256}$
100° to 100°·9...	22	7	15	$5, 2, 1, \frac{7}{8}, \frac{1}{2}, \frac{1}{2}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{1}{16}, \frac{1}{32}, \frac{1}{32}, \frac{1}{32}, \frac{1}{32}, \frac{1}{128}$
101° to 101°·9...	13	5	8	$5, 1, 1, \frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{256}$
102° to 102°·9...	15	1	14	$1, 1, 1, \frac{1}{2}, \frac{1}{2}, \frac{1}{4}, \frac{1}{4}, \frac{1}{8}, \frac{1}{9}, \frac{1}{16}, \frac{1}{16}, \frac{1}{64}, \frac{1}{128}, \frac{1}{128}$
103° to 103°·9...	11	1	10	$5, 3, 1, 1, \frac{3}{4}, \frac{1}{4}, \frac{1}{9}, \frac{1}{32}, \frac{1}{32}, \frac{1}{64}$
Total cases ...	103	34	69	

It will be seen that both these tables show a distinct relation between the presence of *M. melitensis* in the peripheral blood and the patient's temperature; the first showing an increasing ratio of recoveries of *M. melitensis* with the higher temperatures; the second similarly; but no such relationship is visible between temperature and minimal quantity of blood containing *M. melitensis.*

Is there any Relation between the Agglutinating Power of Blood of Mediterranean Fever Cases and the Presence of M. melitensis *therein?*

When commencing the summer examination of these bloods in June, 1904, to corroborate the diagnosis of Mediterranean Fever arrived at by the medical officer in charge of the case, I invariably examined some of the blood drawn for agglutination reaction on *M. melitensis*, and the diagnosis of the cases selected and given is as certain as it can be. After doing a few cases, in was felt it would be of interest to ascertain what, if any, relation existed between high or low agglutinative power and the presence of *M. melitensis* in the blood. It was accordingly necessary to fix on an arbitrary standard to which all recorded agglutination reactions in the series should conform, in no matter what dilution of serum. For the purpose of this work it was therefore laid down that no agglutination reaction would be recorded unless visible under the $\frac{2}{3}$-in. objective of the microscope 15 minutes after contact between diluted serum and emulsion of *M. melitensis* in normal salt solution. The dilutions of the serum were made with a mercury calibrated 5 cub. mm. pipette graduated in $\frac{1}{2}$ cub. mm., the various dilutions and the *M. melitensis* emulsion brought together on a glass slide, which was put in a moist chamber for 15 minutes and then examined under the microscope side by side with a control: and the highest dilution in which agglutination had by then occurred was recorded as the "maximum dilution of patient's blood giving agglutination reaction." It will thus be seen that all these are strictly comparable for both series. This was done for 89 cases out of the 103. It is usual to express a positive agglutination reaction for *M. melitensis* as 1 in "*n*," meaning that 1 bulk of serum in "*n*" bulks of normal saline effects agglutination: this may be expressed as a fraction $\frac{1}{n}$, or again one may say that the agglutinating power of a given patient's serum is "*n*." In the following table in the column "Agglutinating power," the numbers given mean that one bulk of serum diluted with the corresponding number of bulks of normal saline has sufficed to produce agglutination under the conditions already specified; in the column headed "No *M. melitensis*" is placed the number of cases which did not yield *M. melitensis*; in the column headed "Recovery of *M. melitensis*" is placed the number of cases yielding *M. melitensis*, and in the last column are placed the minimal quantities of blood yielding *M. melitensis* for the specified agglutinating power.

Here one can trace no relation between the amount of agglutinating power and the presence or absence of *M. melitensis* in the blood, but there is some indication of a relationship between agglutinating power and minimal quantity of blood yielding *M. melitensis*, which might be tentatively put as follows:—The higher the agglutinating power of a

Agglutinating power.	No *M. melitensis*.	Recovery of *M. melitensis*.	Minimal quantity of blood yielding *M. melitensis* where recovered.	Agglutinating power.	No *M. melitensis*.	Recovery of *M. melitensis*.	Minimal quantity of blood yielding *M. melitensis* where recovered.
			c.c.				c.c.
1 in 20	1			1 in 1080	2		
40	5	3	$\frac{1}{4}$, $\frac{1}{9}$, $\frac{1}{128}$	1200	2	1	$\frac{1}{64}$
100	—	1	$\frac{1}{32}$	1400	1	2	1, 1
200	1	3	$\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{64}$	1500	—	4	5, 1, $\frac{1}{4}$, $\frac{1}{16}$
300	—	1	1	1600	—	2	3, $\frac{1}{4}$
360	—	2	$\frac{3}{4}$, $\frac{1}{6}$	1800	3		
400	—	1	$\frac{1}{64}$	2000	1	7	5, 1, 1, $\frac{1}{2}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{16}$
500	5	8	1, $\frac{1}{2}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{32}$, $\frac{1}{128}$, $\frac{1}{128}$	2200	—	1	1
600	—	4	1, $\frac{1}{16}$, $\frac{1}{64}$, $\frac{1}{128}$	2400	—	1	$\frac{1}{4}$
640	—	1	$\frac{1}{8}$	2500	1	4	1, $\frac{1}{2}$, $\frac{1}{32}$, $\frac{1}{32}$
800	1	5	$\frac{1}{2}$, $\frac{1}{8}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{256}$	2600	—	1	1
1000	2	8	2, 1, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$, $\frac{1}{256}$	3000	—	4	5, $\frac{1}{2}$, $\frac{1}{8}$, $\frac{1}{16}$

blood during the fever, the larger is the minimal quantity of blood yielding *M. melitensis* likely to be; whence one might be tempted to deduce a correlation between high agglutinating power and high resistance to *M. melitensis* invasion on the part of the patient.

For how long is it Necessary to Incubate in Broth Patients' Blood containing M. melitensis *before its Presence can be Demonstrated?*

To obtain an answer to this question, the broth-tube containing the largest quantity of blood was, in 25 cases, used to inoculate, on each of eight successive days after its abstraction, an agar slope which was dated and incubated at 37° C. Seven of these cases failed to yield *M. melitensis,* in the others it made its appearance variably on the slope inoculated 3, 4, 5, 6, 7, or 8 days after commencement of the incubation of the blood in broth as follows:—

Number of days' incubation.	Number of recoveries.	Minimal amounts of blood ultimately yielding *M. melitensis.*
		c.c.
3	3	$\frac{1}{16}$, $\frac{1}{32}$, $\frac{1}{64}$
4	3	1, $\frac{1}{2}$, $\frac{1}{32}$
5	5	1, 1, $\frac{1}{4}$, $\frac{1}{32}$, $\frac{1}{32}$
6	2	1, 1
7	4	5, 5, $\frac{1}{4}$, $\frac{1}{16}$
8	1	3

The general inference to be drawn from this is that, in general, the smaller the "minimal" amount of blood, the earlier *M. melitensis* makes a demonstrable appearance in the blood. The question is of some interest, because Widal, in his similar work on typhoid fever, postulated the hypothesis of the existence in the blood of typhoid cases in variable amounts of what he called "substances empechantes," which delayed the growth of *B. typhosus* in his nutrient broth according to the amount thereof; *B. typhosus,* in his experience, sometimes appearing after one day's incubation, in others not till after eight days. It will be observed that the foregoing cases yield some little support to the theory; for instance, in one case, where the minimal amount of blood was $\frac{1}{16}$ c.c., *M. melitensis* made its appearance after three days; in another case, where the minimal amount of blood was the same, $\frac{1}{16}$ c.c., not till the 7th day.

Diurnal Variation.

In 58 of the 103 cases blood was drawn in the forenoon; in 34 of these cases *M. melitensis* was present, in 24 it was absent; in 45 cases blood was drawn late in the afternoon; *M. melitensis* was present in 35 cases, absent in 10; a ratio of presence to absence of 7 to 5 in the

morning, as against 7 to 2 in the evening; that is *M. melitensis* was $2\frac{1}{2}$ times more likely to be found in blood taken in the late afternoon than in the forenoon; this suggests a correlation between the usually higher temperature of the patient in the afternoon and the presence of *M. melitensis* in his blood.

Summary.

1. *M. melitensis* has been demonstrated to be present in the peripheral blood of 68 per cent. (2 out of 3) of the cases examined in a series of 103 cases.

2. *M. melitensis* exists in the blood in relatively small amount, not having been found in association with a less quantity of blood than 4 cub. mm., and that only in two cases out of 103.

3. The higher the temperature of the cases for a few days before and at the period when blood is abstracted, the more likely is the latter to contain *M. melitensis.*

4. The higher the agglutinating power of a blood during the fever, the larger is the minimal quantity of blood yielding *M. melitensis* likely to be. A correlation is suggested between this and the patient's powers of resistance to *M. melitensis.*

5. The smaller the minimal quantity of blood yielding *M. melitensis*, the earlier is *M. melitensis* likely to be obtained from the nutrient broth in which it is being incubated.

6. *M. melitensis* is more likely to be present in blood abstracted in the late afternoon than in the forenoon. A correlation is suggested between this and usual evening rise of temperature.

7. No definite relation can be established between any chronological stage of the fever and the presence of *M. melitensis* in the blood; it is present both early and late in the disease.

II. ON THE INFECTIVITY OF THE SKIN, BREATH, AND SWEAT OF MEDITERRANEAN FEVER PATIENTS.

By Staff-Surgeon E. A. Shaw, R.N., Member Mediterranean Fever Commission, Malta.

1. *Examination of Skin.*

The epidermis is considerably affected in Mediterranean Fever. Hughes states that "about the fourth week desquamation occurs, being most noticeable on the soles of the feet, where the skin peels off in large flakes, leaving the skin of the feet soft and tender for a considerable time," "during the fourth month towards the end of long attacks or even during early convalescence, the hair falls out extensively." "In long cases the nails have often a grooved longitudinally striated appearance." Consequently, in March of 1904, I set myself to make an attempt to determine if *M. melitensis* is excreted in the cast-off epidermal scales of the skin. After some consideration I determined to put epidermal scrapings from Malta Fever Patients into nutrient broth, incubate this, and then from it to attempt to isolate *M. melitensis* if present.

As the skin is well known to be, even under apparently healthy conditions, largely infected with various organisms, and as any attempt at sterilisation thereof might kill off the somewhat delicate *M. melitensis*, and so baulk the object in view, it was felt that some other method of restricting the presence of organisms which would inevitably overgrow the slow growing *M. melitensis* during the process of isolation would have to be resorted to, and the addition of some antiseptic to the nutrient broth which would to some extent hold back the usual skin organisms, and yet not unduly check the possible *M. melitensis*, seemed the most promising method. Formalin was the antiseptic ultimately decided upon, and a series of preliminary experiments enabled one to determine that broth (made with peptone-Martin, and of an acidity + 5 Eyre's scale) containing 1 in 1000 of sodium formate would, after inoculation with *M. melitensis*, give a good growth thereof in four days; 2 in 1000 delayed growth till sixth day, which was felt to be too long, and less than 1 in 1000 would have defeated the object in view of restraining other organisms. The procedure finally adopted was the following:—

Some of the surface epidermis was removed from each selected Malta Fever patient with a sterilised scalpel by scraping the surface of the arms, chest, thighs, and feet; these scrapings were placed in a numbered, dated, test-tube containing the broth specified, incubated at

37° C. for five days (thus giving one day's margin), then the broth-tube was well agitated, a loopful taken from it and placed in another tube, of same number but new date, containing 10 c.c. sterile broth of the kind specified, this well agitated and mixed, and from this dilution zig-zag stroke inoculations were made on large agar (+ 5 Eyre's scale) slope tubes of same number and new date, the new tubes incubated for five days, the agar slopes examined daily for discrete colonies, which never failed to appear, and all of these resembling *M. melitensis* colonies were subjected to the usual tests; the second broth-tube used to form a similar dilution for third generation in broth and on agar slopes, and these again for Fourth Generation.

A total of 14 patients (the opportunity for obtaining material from whom I owe to the kind courtesy of the officers R.A.M.C. of Valletta and Cottonera hospitals, to whom I beg to tender my warmest thanks), all of which cases were undoubted Mediterranean Fever, ranging from three weeks to three months in duration of disease, were thus examined during April, May, and June, 1904. Every case yielded discrete colonies on the agar slopes, many of them greatly resembling *M. melitensis* colonies at first sight, but proving on further examination to be a white staphylococcus, apparently Welsh's skin staphylococcus, and not one of them turned out to be a colony of *M. melitensis.*

In August the foregoing method was modified as follows, the broth enrichment method being abandoned :—The epidermal scrapings from each patient were thoroughly ground up in 1 c.c. of sterile normal salt solution, one loopful of this was used to plate three successive glucose-litmus-agar Petri dishes; the remaining epidermal emulsion was diluted by the addition of 5 c.c. more normal saline, and the surface of three other similar Petris inoculated by spreading ¼ c.c. of this diluted epidermal emulsion over each, and the six plates then incubated at 37° for five days, at the end of which they were carefully examined for possible colonies of *M. melitensis*, and all likely looking ones put through the usual tests. A total of 71 specimens were thus examined. The accompanying table shows the cases and the day of disease on which specimens were taken, the sign × indicating each examination. The first 14 cases are not included, the day of disease not having been sufficiently accurately recorded.

From none of these bacteriological examinations has *M. melitensis* ever been recovered, but in nearly every plate out of the 426 used in this investigation has been found most constantly a Gram staining glucose fermenting white staphylococcus, presumably the same described by Welsh as associated with the skin, and on taking off the covers of the Petri dishes, a faint sour odour very similar to that noticeable on raising the bed-clothes of a feverish rheumatic patient was generally perceptible, suggesting the possibility of "sour sweats" being due to fermentations set up by this organism.

Table showing Cases and Day of Disease on which Skin was examined Bacteriologically.

Patient's Name.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Mayes																														×											
Francis																																			×						
Hagger																																									
Kelly																																							×		
Wilson																																			×						
Jones																																									
Martin																																									
Lawrence																																								×	
Hewett																	×																								
Hurrell												×																													
Rivers										×																															
Shelly															×																										
Kinsella																																									×
Marchant																										×															
Silburn																															×										
Campbell																																									×
Turner																																									
Donovan																			×				×				×			×											
Rentcome																																									×
Smith																																									
Joyce																																×			×			×			×
Ericson									×													×			×										×						
Warren																																									
Anthony																																									
Bolt																																									
Derby																		×				×																			
Dennis																																									
Gane																																									

Table showing Cases and Day of Disease on which Skin was examined Bacteriologically—*continued.*

Patient's Name.	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Mayes					×																																				
Francis																																									
Hagger									×																																
Kelly																																									
Wilson																																									
Jones																		×																							
Martin									×	×																															
Lawrence												×																													
Hewett																																									
Hurrell																																									
Rivers																																									
Shelly																																									
Kinsella				×			×				×				×				×		×																				
Marchant											×																														
Silburn																																									
Campbell			×																																						
Turner			×							×				×				×																							
Donovan																																									
Rentcome				×				×			×				×			×			×			×					×												
Smith											×				×			×			×			×					×			×									
Joyce																																									
Ericson																																									
Warren				×			×					×			×																										
Anthony																																									×
Bolt																																				×				×	
Derby																																									
Dennis																												×			×										
Gane									×																																

Animal Experiments with Skin Scrapings.

It was necesssary to see also whether any evidence of the presence of *M. melitensis* in the skin of patients could be obtained by animal experimentation, and accordingly the following were undertaken :—

Experiment I.—Monkey No. 54.

A freshly arrived animal whose temperature and whose blood gave not the slightest indication of reaction to *M. melitensis* was set apart for this experiment.

July 21. Epidermal scrapings from the arms, forearms, and flanks of six Malta Fever patients, all between 28th and 35th day of disease, were taken, ground up in 5 c.c. sterile nutrient broth in a small sterilised mortar with a sterile pestle, and the resulting emulsion injected subcutaneously with a sterile syringe between the animal's shoulders, the intention being to first get general evidence, and later work out details.

July 22. Evening temperature had risen to 104° F.

July 24. Injection not yet showing any indication of absorption; persists as a globular swelling.

July 25. Some indication of commencing suppuration near site of injection. Evening temperature 104° F.

July 27. Commencing suppuration of 25th has now aborted. Injection still persists as a globular swelling.

July 29. Injectional swelling now disappearing.

July 31. No trace of agglutination in a dilution of $\frac{1}{20}$.

August 3. Temperature has remained normal since July 24. Again made emulsion of the skin-scrapings from five patients all between 30th and 45th day of disease, and injected subcutaneously.

August 5. No swelling, but some induration at sight of last injection.

August 7. No trace of agglutination reaction in a dilution of $\frac{1}{10}$. This monkey's box is next to that of Monkey No. 55, which, unknown to me, had been artificially infected with Malta Fever, and contact was possible (see note at end of this experiment).

August 9. Evening temperature to-day 104°, though normal from July 26 to this morning.

August 10. Agglutination reaction is present in a dilution of $\frac{1}{10}$ visible to naked eye, in $\frac{1}{20}$ visible under $\frac{2}{3}$-in. objective.

August 11. Temperature again normal. Again repeated injection of epidermal scrapings from four other cases of Malta Fever, all between 30th and 45th day of disease.

August 15. Agglutination reaction present in a dilution of $\frac{1}{10}$ visible to naked eye, and of $\frac{1}{20}$ visible under $\frac{2}{3}$-in. objective.

August 26. Agglutination reaction present as on August 15.

September 5. Agglutination reaction visible to naked eye in a dilution of $\frac{1}{20}$, and in $\frac{1}{40}$ under $\frac{2}{3}$-in. objective.

September 28. Agglutination reaction as on September 5.

October 1. Agglutination reaction as on September 5. There has been no rise of temperature since August 9. Monkey killed with chloroform, an aseptic *post-mortem* made, and two broth-tubes and one agar slope inoculated with small cubes of tissue from the spleen, the broth-tubes each receiving a piece of the organ; similarly the liver and kidney, and all incubated. All organs were healthy, and there was no enlargement of the spleen.

October 8. No growth in any slope of October 1. Now inoculated six slopes from the six broth-tubes of October 1.

October 13. No growth in any slopes of October 1 or October 8. Experiment concluded.

Note.—As mentioned above, this monkey had been unwittingly exposed to the possibility of contact infection from Monkey No. 55, but as the animal cannot be safely said to have developed the fever, this does not matter. It had an occasional rise of temperature, but lasting only a day. No *M. melitensis* was recovered *post-mortem*, and an agglutination of $\frac{1}{40}$ alone is insufficient on which to base a diagnosis, and I should consider the development of this reaction due to the injection of *M. melitensis* toxins (contained in the skin). Of the action of toxins in producing the agglutination reaction I give experimental evidence in another section of this Report.

Experiment II.—Monkey No. 68.

During the first weeks of the last experiment the possibility of excretion of *M. melitensis* in the urine became an established fact, and as then the possibility of patients infecting the skin of their flanks with their own urine had to be considered, it was resolved that henceforth only scrapings from the upper arms of patients should be used. Further, the monkey (No. 68) used for this second experiment had his box put in a corner with no neighbour on his left, and the monkey used in the preceding experiment on his right, and as the latter did not develop the fever, and No. 68 was within reach of no other, he must be considered as not having been exposed to the risk of contact infection.

Monkey No. 68 was kept under observation from August 12 to 20; during this period his temperature varied from 100°—103°·2; blood presented no trace of agglutination reaction with *M. melitensis.*

August 20. Epidermal scrapings from upper arms of five patients, all between 30th and 60th day of disease, were emulsfied as before, and injected between shoulders subcutaneously.

August 26. There has been no fever since last note, and to-day there is no trace of agglutination reaction.

August 27. Second injection of arm scrapings from two patients, both in 91st day of disease.

September 2. Third injection of arm scrapings of three patients, all between 60th and 90th day of disease.

September 5. Agglution reaction present in a dilution of $\frac{1}{10}$, not beyond.

September 9. Ill, and off his feed.

September 10. Died between 5 and 7 P.M. In my absence an immediate *post-mortem* was made by Major Horrocks, who notes: "Very emaciated, maggots on skin of face, spleen and kidneys appeared slightly congested, other viscera appeared normal. Made cultures from spleen and kidney."

September 19. Agar slopes inoculated from spleen on 10th have remained sterile. Kidney slopes planted from broth on 14th also sterile; reinoculated these.

September 20. Reinoculated spleen slopes.

September 25. All remain sterile.

Result.—No development of fever, but development of a low ($\frac{1}{10}$) agglutination reaction, probably the result of injection of *M. melitensis* toxins in the epidermal scrapings. No *M. melitensis* recovered *post-mortem.*

Experiment III.—Monkey No. 62.

This experiment was commenced by Major Horrocks, and was turned over by him to me to complete on September 28, just prior to his departure for England. For convenience of comparison, I will briefly recapitulate Major Horrocks' notes.

Monkey No. 62 had had its blood frequently examined during August, and up to commencement of the experiment, and its temperature had been daily recorded. It was absolutely free from any suspicion of Malta Fever.

September 16. Monkey No. 62 received an injection of skin scrapings from arms and axilla of a fever patient, ground up in normal saline solution.

September 21. Blood examined, no agglutination reaction to *M. melitensis.*

September 24. Skin scrapings from same patient again injected.

September 26. Blood again examined. No agglutination reaction to *M. melitensis.*

September 27. Skin scrapings from same patient again injected.

September 30. This morning monkey was too sick to have his temperature taken. Died at 10.30 A.M. *Post-mortem* made at once. All organs seemed healthy. No cause of death discoverable. Inoculated broth-tubes and agar slopes from spleen, kidney, liver and heart's blood and incubated.

October 7. No growth on any slope of September 30. Incubated fresh slopes from broth-tubes of September 30.

October 12. No growth on any slope of October 7. Experiment concluded.

Result.—No development of Malta Fever. No development of agglutination reaction. No recovery of *M. melitensis*, *post-mortem.*

Note.—This experiment differs from the other two preceding it only in the non-appearance of the agglutination reaction; but, as in Experiment I, Monkey No. 54, the first skin injection was given July 21, and the *agglutination reaction* did not appear till August 10, an interval of 21 days, nor in Experiment II, Monkey No. 68, till after an interval of 16 days; nor in Experiment IV, Monkey No. 74, next to be described, till after an interval of 22 days; nor in Experiment V, Monkey No. 65, to be described next but one, till after an interval of 23 days; I think one is entitled to consider that as Monkey No. 62, Experiment III, died 14 days after its first skin injection, an interval shorter than any of those just cited, that there had not been time for the agglutination reaction as observed in the others, to develop.

Experiment IV.—Monkey No. 74.

This experiment, like the last, was commenced by Major Horrocks on September 12, during my absence, and turned over to me on September 28 to complete. Blood had prior to experimentation been frequently examined, but had never exhibited the slightest agglutination reaction with *M. melitensis.* There was never any possibility of contact infection.

September 12. Injection of emulsified skin scrapings from arms and axilla of one Mediterranean Fever patient.

September 17. Blood examined. Serum in a low dilution appeared to have a tendency to agglutinate *M. melitensis.*

September 23. Blood again examined. Serum in a dilution of 1 in 10 showed no sign of agglutinating *M. melitensis* after contact of one hour.

September 25. Second injection of skin scrapings emulsified in normal saline.

September 27. Third injection of skin scrapings.

September 28. Blood examined. No agglutination reaction.

October 3. Fourth injection of skin scrapings.

October 4. Blood gives a distinct agglutination reaction in a dilution of $\frac{1}{40}$ in 15 minutes visible under $\frac{2}{3}$-in. objective.

October 8. Fifth injection of skin scrapings from three patients.

October 11. Blood gives distinct agglutination reaction in a $\frac{1}{80}$ dilution after 15 minutes visible to naked eye.

October 15. Sixth injection of skin scrapings from same three patients.

October 18. Agglutination reaction visible to naked eye in $\frac{1}{80}$ dilution.

October 19. Seventh injection of skin scrapings from three patients.

October 22. Eighth injection of skin scrapings from two patients.

October 25. Agglutination reaction in $\frac{1}{40}$ dilution visible to naked eye and in $\frac{1}{60}$ visible under $\frac{2}{3}$-in. objective.

October 26. Ninth injection of skin scrapings from four patients.

October 28. This morning this monkey was found dead. *Post-mortem.* Stomach much dilated with gas. Organs all apparently healthy, much muscular wasting, abscesses at sites of injections. Broth-tubes and agar slopes inoculated from all organs and incubated.

November 2. Agar slopes of October 28 all sterile. Inoculated fresh agar slopes from broth tubes and incubated.

November 7. Agar slopes of November 2 sterile, as are also those of October 28. Experiment concluded.

Result.—Injection of skin scrapings has not been followed by fever, but has developed an agglutination reaction in the serum in low dilution appearing after an interval of 22 days from date of first injection.

Experiment V.—Monkey No. 65.

This monkey had been bitten in September by supposedly infected mosquitoes, but had never had any fever, nor had its blood, which with the others had been examined as a routine measure, once a week, ever shown any sign of agglutinating power on *M. melitensis.*

October 30. This monkey received an injection of epidermal scrapings from arms of four Mediterranean Fever patients.

November 3. Second injection of skin scrapings from four patients.

November 6. Third injection of skin scrapings from four patients.

November 7. Agglutination reaction = a slight tendency only visible in $\frac{1}{10}$, $\frac{1}{20}$ and $\frac{1}{40}$ dilutions, insufficient to call positive.

November 10. Fourth injection of skin scrapings from arms of four patients.

November 13. Fifth injection of skin scrapings from arms of four patients.

November 15. Agglutination reaction = nil in dilutions of $\frac{1}{10}$, $\frac{1}{20}$, and $\frac{1}{40}$.

November 16. Sixth injection of skin scrapings from arms of four patients.

November 19. Seventh injection of skin scrapings from arms of four patients.

November 22. Agglutination reaction distinct traces in $\frac{1}{10}$ and $\frac{1}{20}$ dilutions only.

November 24. Eighth injection of skin scrapings from arms of four patients.

November 27. Ninth injection of skin scrapings from arms of four patients.

November 28. Agglutination reaction marked in $\frac{1}{10}$ and $\frac{1}{20}$ dilutions.

December 1. Tenth injection of skin scrapings from arms of four patients.

December 4. Eleventh injection of skin scrapings from arms of four patients.

December 5. Agglutination reaction only in $\frac{1}{10}$ dilution visible under $\frac{2}{3}$-in. objective.

December 12. No agglutination reaction.

December 19. No agglutination reaction.

December 26. No agglutination reaction.

January 3. No agglutination reaction.

January 9. No agglutination reaction.

January 16. No agglutination reaction.

January 23. No agglutination reaction.

Experiment concluded. Monkey used for other experiments.

Result.—Infection of skin scrapings has not been followed by fever, but has developed in the blood a low agglutination reaction on *M. melitensis* after an interval of 23 days.

Remarks.—Summarising in tabular form the foregoing five experiments we get the following (see Table, p. 30).

In none of these monkeys can Malta Fever be said to have developed. The appearance of a low agglutination reaction alone is not sufficient on which to base a diagnosis and may, I think, safely be attributed to the presence of *M. melitensis* toxins in the skin scrapings used. It is to be noted that the highest dilution in which it was obtained was $\frac{1}{80}$; this is identical with the highest dilution which the agglutination reaction was obtained in Monkeys 58 and 59, which each received injections of the filtrate from broth in which *M. melitensis* had been cultured (*vide* toxin experiments), and both contrast markedly with the high dilution $\frac{1}{1000}$, $\frac{1}{2000}$, $\frac{1}{3000}$, $\frac{1}{3500}$ in which agglutination is quite usually obtainable in monkeys which have received living *M. melitensis* in any experimental manner. The occasional elevations of temperature are attributable to the presence of staphylococci in the skin scrapings used, which had a decided tendency to produce abscess formation.

The point with regard to the toxins was felt to be an important one, and accordingly an effort was made to resolve it by an experiment which was commenced by Major Horrocks on September 22 and continued by me from September 28 to its conclusion on December 26.

Experiment number.	Monkey number.	Different samples of epidermis.	Number of injections.	Date of first injection.	Date of appearance of agglutination reaction.	Number of days required to develop agglutination.	Highest dilution which gave agglutination.	*Post-mortem* examination for *M. melitensis*.
I	54	15	3	July 21	Aug. 10	20 days	$\frac{1}{20}$	Not recovered.
II	68	10	3	Aug. 20	Sept. 5	16 ,,	$\frac{1}{40}$	Not recovered.
III	62	3	3	Sept. 16	Never appeared. Died Sept. 30	...	...	Not recovered.
IV	74	18	9	Sept. 12	Oct. 4	22 days	$\frac{1}{80}$	Not recovered.
V	65	44	11	Oct. 30	Nov. 22	23 ,,	$\frac{1}{20}$	No *post-mortem*.

Experiment VI.

Monkey No. 61A. Had never had any elevation of temperature and had never presented agglutination reaction.

September 22. Skin scrapings from arms and axillæ of two Malta Fever patients were ground up with sterile normal salt solution into a fine emulsion. A sterile Berkefeld candle was fitted to a sterile test-tube, the emulsion filtered, and the filtrate injected subcutaneously into Monkey No. 61A.

September 24. Sweat obtained from three Malta Fever patients, similarly filtered and filtrate injected.

September 26. Blood presented no agglutination reaction.

October 3. Blood presented no agglutination reaction.

October 6. Injected filtered sweat from one patient.

October 8. Skin scrapings from three patients ground up in 15 c.c. sterile salt solution, allowed to macerate at laboratory temperature, 68° F., for two hours, filtered through Berkefeld candle and filtrate injected.

October 10. Blood presented no agglutination reaction.

October 15. Skin scrapings from three patients treated as on October 8 and filtrate injected.

October 17. Blood presented no agglutination reaction.

October 19. Skin scrapings and sweat from four patients treated as on October 8, and filtrate injected.

October 22. Skin scrapings and sweat from three patients treated as on October 8, and filtrate injected.

October 24. Blood presented no agglutination reaction.

October 26. Skin scrapings from four patients treated as on October 8, and filtrate injected.

October 30. Skin scrapings from four patients treated as on October 8, and filtrate injected.

October 31. No agglutination reaction.

November 3. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 6. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 7. Blood presented no agglutination reaction.

November 10. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 13. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 14. Blood presented no agglutination reaction.

November 16. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 19. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 21. Blood presented no agglutination reaction.

November 24. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 27. Skin scrapings from four patients treated as on October 8, and filtrate injected.

November 28. Blood presented no agglutination reaction.

December 1. Skin scrapings from four patients treated as on October 8, and filtrate injected.

December 4. Skin scrapings from four patients treated as on October 8, and filtrate injected.

December 26. Blood has been examined weekly since last note and also to-day and has never presented any agglutination reaction with *M. melitensis.*

Experiment concluded.

Remarks.—This experiment, so far as it goes, would appear to negative the explanation given of the appearance of the agglutination reaction in four out of the five preceding experiments, but it is to be observed that it takes for granted one important point, *i.e.*, that *M melitensis* "toxins" are soluble in normal salt solution. This point is reserved for future experiments, as it does not affect the main inference to be drawn from this series of experiments.

Conclusion.—The active infective agent of Mediterranean Fever is not excreted by the skin.

2. *Examination of Breath.*

With a view to obtaining experimental evidence on this question it was determined to instruct patients to gently blow through sterile broth contained in sterile tubes and examine this broth bacteriologically. Broth tubes were fitted with rubber corks bored with two holes, through one of which was passed a long glass entry tube, bent outside the broth-tube at an obtuse angle of about 150°, length outside broth-tube being about 3 inches, inside dipping beneath surface of broth; through the other hole in the rubber cork was passed a short straight glass air-exit tube lightly plugged with sterile cotton wool 1-inch in length on each side of the rubber cork. The patients whose breath it was desired to examine, were instructed to blow gently down the long entry tube at frequent intervals during one hour, their expired air gently bubbling through the broth. In experiments made before the present series the entry tube outside the broth-tube was fitted with a longish piece of rubber tube and a glass mouth-piece, but it seemed to me that if expired air contained any microbes there was great risk of these being caught by the moist inner surface of the rubber tube, on which a considerable proportion of the water vapour contained in all expired air was found to condense.

First Method.—These broth-tubes on arrival at the laboratory had

their rubber corks and glass tubes removed, were replugged with sterile cotton wool, incubated for seven days at 37°, and then one loopful from each distributed over the agar surfaces of two large-sized Petri dishes, which were incubated for five days at 37°, and then examined for individual *M. melitensis* colonies. A total of 86 such breath-tubes were examined in the manner described, but *M. melitensis* never appeared in any plate, though other organisms, not examined in detail, did.

Second Method.—At this stage other experiments on the vitality of *M. melitensis* growing with other organisms (see Section on Vitality of *M. melitensis* outside the Body, p. 43) had shown that *M. melitensis* had not much chance of surviving in a fluid nutrient medium with other microbes. Accordingly from each broth-tube immediately on its arrival at the laboratory, after well shaking, a loopful was taken and distributed over the agar surface of two Petri dishes, the tubes then plugged with sterile cotton wool and both tubes and plates incubated. At the end of five days these "direct" plates were carefully examined for *M. melitensis*, and at the end of seven days' incubation a loopful from each breath broth-tube was distributed over two agar plates and these also examined after five days' incubation for possible *M. melitensis*. One thus had two series of plates, one direct, the other after the incubation of the breath-infected broth. A total of 24 breath-tubes were treated in this manner, but no *M. melitensis* ever appeared on any plate, though the same type of other organisms as before were found.

Third Method.—By this time experiments with *M. melitensis* in association with other organisms had shown that a period of three days was as long as one could expect to recover *M. melitensis* when incubated in broth with other organisms. Accordingly the "direct" series of plates was continued as before, but the breath broth-tubes were only incubated for three days and then plated.

I examined 115 breath broth-tubes in this way, but not in one did I find a single *M. melitensis* colony.

A total of 225 such broth-tubes were examined, and in connection therewith 728 agar Petri plates were prepared and examined, all without result so far as the particular quest involved was concerned. I append a table showing names of patients and day of disease in each case in which breath broth-tubes were prepared, which is indicated in each case by the sign ×. It will be seen that practically the whole period of the disease has been covered.

Table showing Cases and Day of Disease on which Breath was Examined Bacteriologically.

Patient's name.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
Anthony ……																×																															
Rivers ………																																							×								
Silburn ……																			×			×						×				×	×											×		×	
Tripp ………																																	×														
Anderson …																											×																				
Rentcome …																				×			×																								
Russell ……																																			×			×			×						
Marchant …																		×																													
Donovan ……		×							×		×	×	×	×	×	×										×										×	×		×	×		×		×			
Kinsella ……																																						×						×	×	×	×
Campbell …																																				×		×	×	×	×	×	×	×			
Dinegan ……																			×																												
Joyce ………							×	×								×	×		×						×																	×		×	×	×	×
Grimwood …																×	×		×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		
Groom ……																																															
Fletcher ……											×																																				
Tait …………											×		×																																		
Smith ………																																															
Turner………																																															
Dennis………																																															
Ericson ……																	×	×																×													
Darby ………																						×	×	×	×	×	×																				
Walker ……							×	×	×		×	×																																			

Table showing Cases and Day of Disease on which Breath was Examined Bacteriologically—*continued.*

Patient's name.	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
Anthony																																														
Rivers																																														
Silburn			×		×	×	×	×	×	×	×	×	×																																	
Tripp																																														
Anderson ...																																														
Rentcome ...																																														
Russell											×		×		×		×		×		×		×																							
Marchant ...																																														
Donovan																																														
Kinsella	×	×	×		×	×		×		×		×	×	×		×		×		×	×	×		×		×																				
Campbell ...																																														
Dinegan																																														
Joyce	×	×	×	×				×																																						
Grimwood ...		×	×	×	×	×	×	×	×	×	×		×	×	×	×		×	×	×	×	×		×	×																					
Groom.........													×		×		×	×			×	×	×	×	×	×	×			×	×	×														
Fletcher																																														
Tait																																														
Smith					×	×	×	×	×	×	×		×		×	×	×	×		×	×	×	×	×		×				×																
Turner.........																		×	×	×	×	×		×		×		×							×	×	×	×				×			×	
Dennis.........										×		×		×		×	×	×	×	×	×	×	×	×	×	×	×	×		×	×															
Ericson																																														
Darby																																														
Walker																																														

In order to further investigate the possibility of the infection of Malta Fever being given off in the breath, animal experimentation was also resorted to; portions of such of the foregoing broth-tubes as presented growth being injected in quantities usually of 10 c.c. into two monkeys. This was commenced in the first monkey, No. 73, by Major Horrocks, September 16, and continued by me from September 28 till this monkey's death on November 1; in the second monkey, No. 43, commenced and concluded by me alone.

Monkey No. 73.—This animal had never been used for any other experiment.

September 15. Blood examined. No reaction to *M. melitensis.*

September 16. Injected contents of broth-tube infected by Malta Fever patient's (Lawrence) breath in which growth had occurred after incubation.

September 21. Similar injection (Silburn).

September 28. Blood examined. No reaction to *M. melitensis.*

October 3. Big abscess at site of former injections. To-day injected a growth in breath broth-tube (Anderson) on opposite side.

October 4. Blood examined. No reaction to *M. melitensis.*

October 6. Injected broth growths from breath of Rentcome and Marchant, 5 c.c. from each.

October 9. Similar injection (Silburn).

October 11. Blood examined. Agglutination reaction with *M. melitensis* in $\frac{1}{40}$ dilution under $\frac{1}{6}$-in. objective.

October 12. Injected broth growths from breaths of Campbell, Joyce and Silburn, 3 c.c. each.

September 16. Injected broth growths from breaths of Campbell, Grimwood and Kinsella, 3 c.c. each.

October 18. Blood presents agglutination reaction in a dilution of $\frac{1}{100}$ visible to naked eye.

October 19. Injected broth growth from breaths of Campbell and Grimwood, 5 c.c. of each.

October 23. Injected broth growths from breaths of Campbell, Kinsella, and Joyce, 3 c.c. of each.

October 25. Agglutination reaction in a dilution of $\frac{1}{100}$ visible to naked eye.

October 26. Injected broth growths from breaths of Fletcher, Groom, Russell and Tait, $2\frac{1}{2}$ c.c. from each.

October 29. Monkey ill. Considerable diarrhœa and wasting.

November 1. Monkey obviously dying. Euthanasia cum chloroform. *Post-mortem.*—Much wasting, no obvious cause of death, organs all apparently healthy, gas in intestines. Agar slopes and broth-tubes inoculated from all organs and incubated.

November 6. Agar slopes of November 1 all sterile. Inoculated fresh slopes from broth-tubes of November 1.

November 11. Agar slopes of November 6 also sterile.

Experiment concluded.

Monkey No. 43.—This animal, in July, on the 16th and 18th, had received injections of the filtrate through filter paper of supposedly infected soil macerated in sterile water, but had never developed Malta Fever, nor had its blood ever reacted to *M. melitensis* in any dilution whatever, though frequently examined.

October 3, 10, 17, 24. No trace of agglutination reaction in dilutions of $\frac{1}{10}$, $\frac{1}{20}$, or $\frac{1}{40}$.

October 27. Injected broth growth from breaths of Grimwood, Joyce and Silburn, 3 c.c. from each.

October 31. Injected broth growth from breaths of Donovan and Silburn, 5 c.c. from each. No agglutination reaction in $\frac{1}{10}$, $\frac{1}{20}$ or $\frac{1}{40}$ dilutions.

November 4. Injected broth growth from breaths of Groom and Silburn, 5 c.c. each.

November 7. A doubtful tendency to agglutination in $\frac{1}{10}$, $\frac{1}{20}$ dilution under $\frac{1}{6}$-in. objective. Abscess at the site of last injection but one.

November 8. Injected broth growth from breaths of Turner and Kinsella, 5 c.c. each.

November 12. Monkey somewhat ailing.

November 14. No agglutination reaction.

November 17. Injected broth growth from breath of Grimwood, 10 c.c.

November 21. Injected broth growth from breaths of Dennis and Grimwood, 5 c.c. each.

November 21. No agglutination reaction.

November 28. Slight agglutination reaction in $\frac{1}{10}$ and $\frac{1}{20}$ dilutions under $\frac{2}{3}$-in. objective.

December 1. Injected broth growth from breaths of Darby and Walker, 5 c.c. each.

December 4. Injected broth growth from breaths of Darby, Walker, and Turner, 5 c.c. each.

December 5. Tendency to agglutination in $\frac{1}{10}$ dilution.

December 12. No agglutination reaction. Very weak, thin and emaciated; has been seedy for some days.

December 15. Dying. Gave chloroform. *Post-mortem*, found pneumonia and pericarditis left side. Inoculated slopes and broth-tubes from all organs.

December 23. No *M. melitensis* recovered *post-mortem*, but a glucose fermenting + Gram-staining coccus was obtained from spleen, liver and kidney; nothing from heart's blood and lungs.

Remarks.—There is to be noticed in both these animal experiments the development of a low agglutination reaction, and here as in the

skin experiments I should attribute this to the ingestion of *M. melitensis* toxins, as I consider it practically certain that in breathing out through the broth-tubes, a certain amount of saliva trickled down the long entry tube and so into the broth; the possibility of this was considered at the time and efforts were made to arrange some method of passing breath containing possibly *M. melitensis*, while excluding saliva; but none free from objection was found, hence it was decided to proceed as described, and if *M. melitensis* were obtained, to examine the saliva of patients independently for this micro-organism. In neither monkey could it be said that Mediterranean Fever was developed. The agglutination reaction developed was much too low, the occasional rises of temperature observed were attributable to abscess formation, or to other micro-organisms, not *M. melitensis*, contained in the broth growths which were injected. In both cases temperatures were taken morning and evening all through the experiments.

3. *Examination of Sweat.*

Critical sweats are a not infrequent and quite characteristic feature of Mediterranean Fever, and it has been often felt that it was not impossible that the *Micrococcus melitensis* might be passed out of the body in this secretion. To determine this exhaustively, I made a bacteriological examination of 251 specimens of sweat obtained from patients in the Military Hospital at Valetta. The method adopted was varied from time to time, as will be described.

First Method.—A skin surface of forearm washed with spirit soap, then ether, a carbolic pad 1 in 40 kept on 12 hours, then a circle of sterilised (dry, 160° C. in air) lint, placed on this surface, and a sterilised watch glass strapped over it with adhesive plaster. After critical sweating, circle of lint removed, placed between two sterilised watch glasses held in a metal frame, and sent to me at laboratory. There each circle of lint placed in a separate broth-tube numbered, dated, and incubated at 37° C. After five days' incubation, agar slopes inoculated zig-zag from each, were incubated at 37° C., and examined daily for growth; if sterile, original broth-tubes were inoculated with *M. melitensis*, returned to incubator for four days, and then fresh slopes inoculated from them; on these *M. melitensis* invariably appeared, thus proving that sufficient disinfectant to prevent growth of *M. melitensis* had not been carried into circles of lint from disinfection of skin surface.

Nineteen sweat swabs from different patients were thus examined. In some cases the tubes remained sterile, in others the agar slopes yielded growth in discrete colonies.

Result.—No *M. melitensis* was ever recovered by this method.

Second Method.—The critical sweat was collected in sterile pipettes from four different patients, zig-zagged on agar and incubated. The

collection was done by the sisters in the ward, who were supplied with the pipettes ready for use, and instructed how to break the point and apply them. They stated it was rare for sweat to collect in such large drops as to admit of collection in this manner, hence specimens were obtained from only four patients.

Result.—No *M. melitensis* was obtained.

Third Method (a modification of the first).—Circles of lint were obtained saturated with critical sweat from Malta Fever patients as in first method, but instead of being incubated in broth-tubes, were placed each in a 5 c.c. sterile normal salt solution tube, in which they were thoroughly agitated and ground up with a sterile glass rod, and the resulting fluid plated out in agar Petri dishes both by spreading $\frac{1}{2}$ c.c. of it over whole surface, and by describing a centripetal spiral with a loopful of the fluid. Discrete colonies were always thus obtained after incubation at 37° C. The critical sweat of seven patients have been thus examined without *M. melitensis* having been obtained.

Fourth Method.—The circles of lint saturated with sweat obtained as in the first method were each placed in a separate broth-tube which was incubated at 37° C. for seven days; then a loopful was taken and placed on the surface of nutrose-glucose-litmus-agar in a Petri dish and spread over it by means of a Klein's platinum spreader, which, after completely going over the agar surface, was straightway passed over the surface of a second similar Petri plate. These plates were then incubated for five days, after which they were examined carefully for possible *M. melitensis* colonies. A total of 81 specimens were thus examined.

Result.—No *M. melitensis* were recovered.

Fifth Method (a modification of the third).—It seemed not unlikely that, supposing *M. melitensis* to be present in the circles of lint saturated with critical sweat, that it would be more likely to be obtained directly without previous incubation if nutrient broth were used instead of the salt solution, specified in Method 3; so, accordingly, the circles of lint were placed in separate broth-tubes, and thoroughly stirred up and agitated therein with a sterile Klein's spreader, followed by a vigorous shaking. Then one platinum loopful was immediately spread over an agar plate and incubated for five days at 37°, and then examined for possible *M. melitensis* colonies. The broth-tubes containing the sweat-saturated lint were incubated seven days, and then one loopful spread over two agar plates. These similarly incubated five days and then examined.

A total of 24 specimens were thus treated, but no *M. melitensis* was ever obtained on either series of plates.

Sixth Method.—At this stage of the examination the results of other experiments (see Section on Vitality of *M. melitensis* outside the Body) indicated that *M. melitensis* could not be expected to be recovered

after three days in a nutrient medium containing other organisms; so consequently the procedure of the fifth method was modified by reducing the period of incubation of the sweat-saturated lint in broth to three days instead of seven, being otherwise identical.

A total of 30 specimens were so examined, but again no *M. melitensis* was ever obtained from either the plates inoculated the day the specimen was received, or from those inoculated from the broth-tubes after three days' incubation.

Seventh Method.—Instead of grinding up and shaking the sweat-saturated piece of lint in nutrient broth, and immediately plating a loopful of this, the piece of lint as received was placed flat on the agar surface of a Petri dish and pressed well on to the agar with a sterilised Klein's spreader, then it was lifted up with a pair of sterilised forceps and removed with the same surface downwards to the next adjacent area of agar, and there again pressed on to the agar; this process was repeated until the whole of the agar surface of the Petri dish was covered with "impressions" made from one surface of the piece of lint, usually 30 to 40 for a 10-centimetre Petri. Now another agar Petri was taken, and the same process repeated, but with the other surface of the lint, and both Petri dishes put in incubator at 37° C.; this completed, the piece of lint was then put in a broth-tube and incubated three days at 37° C., and then one loopful plated over two agar Petris.

A total of 86 specimens were thus examined, but no *M. melitensis* was ever obtained either from the direct series of "impression" plates or from the broth-tubes containing the circles of sweat-saturated lint. Frequently in the course of the examination one met with the colonies of *plus* Gram-staining glucose fermenting staphylococci, which turned up almost invariably in these bacteriological examinations of the skin.

The accompanying table (pp. 41, 42) shows the patients and the day of disease on which a specimen was taken; it will be seen that practically every day of the disease is represented by one or more examinations. The numbers on the top line indicate the day of disease, one column being given to each; the sign × indicates that an examination was made, being placed in the vertical column of the day of disease, and in the horizontal column appropriated to the name of the patient from whom it was taken.

It was found practically impossible to obtain sweat in such quantity as to admit of satisfactory injections into animals, but the number of specimens (251) examined, covering every period of the disease, and the varying methods employed, some of which succeeded so admirably in the isolation of *M. melitensis* from the blood and the urine of patients, practically justify the assumption that *M. melitensis* is not excreted in sweat of Malta Fever patients, or it would have been recovered in one of these numerous attempts.

Result.—*M. melitensis* has not been recovered from the 251 specimens of sweat examined, and in all probability is not excreted in this secretion.

Table showing Cases and Day of Disease on which Sweat was Bacteriologically Examined.

Patient's name.	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Pigott........																																								×							
Wilson									×																																						
Hagger																								×															×								
Kelly													×																																		
Markham ...									×								×																														
Mayes																			×								×																	×			
Francis																								×								×															
Lawrence ...																																				×											
Martin																																														×	
Jones																																															
Hewett																					×																										
Pudney																																													×		
Curry								×																											×	×	×	×	×	×		×					
Vincent																																															
Rivers																														×																	
Hurrell																																													×		
Anthony ...								×	×																							×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Marchant ...						×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×	×	×		×
Silburn											×	×	×	×	×	×	×	×	×	×	×	×	×	×																							
Kinsella......																																	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Turner																																															
Anderson ...																																															
Dennis																																										×	×	×	×	×	×
Derby........			×	×	×	×	×	×	×	×	×	×	×	×	×	×	×																														
Ericson																							×	×	×	×	×																				

Table showing Cases and Day of Disease on which Sweat was Bacteriologically Examined—*continued.*

Patient's name.	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102
Pigott																																														
Wilson	×																																													
Hagger																																														
Kelly																																														
Markham																																														
Mayes																																														
Francis																																														
Lawrence																																														
Martin	×																																													
Jones								×																																						
Hewett																																														
Pudney																																														
Curry																								×																						
Vincent																																														
Rivers																																														
Hurrell																																														
Anthony	×	×	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×	×	×	×	×	×	×	×					×		×	×													
Marchant	×	×	×				×		×		×		×	×	×	×		×																												
Silburn																																														
Kinsella	×	×	×	×	×	×	×	×	×	×		×	×	×																																
Turner										×	×	×																							×	×	×	×	×	×						
Anderson										×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×									
Dennis	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×																														
Derby																																														
Ericson																																														

III. ON THE VITALITY OF THE *MICROCOCCUS MELITENSIS* OUTSIDE THE BODY IN DIFFERENT ENVIRONMENTS.

By Staff-Surgeon E. A. Shaw, R.N., Member Mediterranean Fever Commission, Malta.

In attempting to ascertain the presence or otherwise of *M melitensis* in the skin, sweat, breath, etc., of patients suffering from Malta Fever, it was obviously of some importance, having regard to the slow growth of this organism, as compared with the rapid growth of others in nutrient broth, a medium which could not be dispensed with, to ascertain for how long it could be recovered when incubated in broth in association with other micro-organisms, and accordingly the following experiments were undertaken, a control inoculation of the *M. melitensis* used being made into a tube of the same broth to verify its viability, the same generation of *M. melitensis* being used throughout.

A. *Vitality of* M. melitensis *in Mixed Broth Culture.*

No. 1. A sterile broth tube was inoculated with *M. melitensis*, and also from a broth tube (similarly with the same platinum loop) which had been allowed to become contaminated by exposure in the laboratory. This tube was well shaken and then one loopful was distributed over the surface of three successive agar Petri dishes with a Klein's spreader, and then tube and plates placed in incubator at 37°; each day another series of three plates was similarly inoculated from the broth tube, which was each time returned to the incubator, and after a period of five days' incubation, each set of three Petris was carefully examined for *M. melitensis*. This was found in the plates inoculated from the mixed broth culture after it had been incubated seven days, but not later.

No. 2. A repetition of No. 1. The result was the same. *M. melitensis* was recovered from the mixed culture for seven days, but no longer, in both cases the mixed culture at the termination of the experiment, 15th day of incubation, was slightly alkaline to litmus.

Nos. 3 and 4. On the same lines as No. 1; but in these two the mixed culture was composed of *M. melitensis* plus organisms derived from sweat, skin, and urine of Malta Fever cases, as far as possible equal quantities of each being taken. In No. 3, *M. melitensis* was recovered after two days' incubation, not later. In No. 4, started a week later, but with skin, sweat, and urine organisms from different sources, *M. melitensis* was not recovered at all. In both the reaction of the

mixed broth culture was acid to litmus at the termination of the incubation (seven days).

Nos. 5, 6, 7, 8, 9, and 10. In each of these, performed successively, not collectively, the same procedure as in No. 1 was followed, the organisms used being *M. melitensis*, and cultures derived from skin, breath, and sweat. In none was *M. melitensis* recovered after more than *one* day's incubation, and in all the mixed broth culture was acid to litmus at the end of each incubation.

Result.—M. melitensis incubated in broth in presence of other organisms is recoverable for a very short time, seven days, in presence of alkali producing organisms. One to two days in presence of acid-producing organisms contrasting greatly with its recoverability in pure broth culture, from a tube of which, inoculated December 12, 1904, it was recovered by a sub-culture on agar, April 25, 1905, an interval of over four months.

B. *Vitality of* M. melitensis *in Pure Culture.*

1. *On agar agar dry.*—Two agar slopes inoculated with *M. melitensis* March 29, 1904, which had been incubated at 37° C. for four days and then placed aside in laboratory cupboard with cotton wool plug unprotected by a rubber cap, had on December 30, 1904, become so dry that no colony could be detached for sub-culture, and the agar itself had contracted to a thin shred; sterile broth was therefore added to the two tubes until the upper level of the dry culture was submerged, these were then placed in the incubator at 37° C. till January 4, when the broth of one had become turbid, this was now sub-cultured, and pure *M. melitensis* was recovered and verified. No growth was obtained from the other.

Two similar slopes inoculated April 5, 1904, examined January 24, 1905, failed to give any growth. Two other such slopes inoculated April 21 and 24, 1904, similarly examined March 20, 1905, failed to give any growth.

Result.—M. melitensis had remained alive and capable of reproduction in a dried-up condition on agar from March 29 to December 30 = 276 days (nine months).

2. *In Litmus Milk.*—A tube of litmus milk inoculated with *M. melitensis* (Second Generation, Human Spleen, Bowles), December 12, 1904, yielded *M. melitensis* in sub-culture April 26, 1905, a period of over four months, but in very small quantity, a loopful which in January and February had yielded colonies by the hundred, now giving only 1 to 10 colonies; and after May 5 ceased yielding colonies though experimented with for a fortnight longer, hence, presumably dead after 144 days of vitality.

3. *In Nutrient Ordinary Beef-Peptone Broth.*—A tube of this was inoculated from same source at same time as litmus milk, December 12,

1904, and right up to June 3, 1905, each loopful taken twice weekly for sub-culture was yielding a plentiful supply of *M. melitensis.*

Result.—Still alive and actively reproductive after $5\frac{2}{3}$ months in nutrient broth.

In all these the media were titrated to a reaction of + 10 of acidity with phenol-phthaleine (Eyre's scale).

Results.

M. melitensis lived on dry agar	276 days.
,, ,, in litmus milk	144 ,,
,, ,, nutrient broth........................	173 ,,

C. *Vitality of* M. melitensis *in Urine.*

A noteworthy feature of the urine of Mediterranean Fever patients is the length of time it remains acid after it has been passed; the following observations given in tabular form demonstrate this. These urines were taken from patients in the wards without special precautions and were kept in the laboratory cupboard, again without any special precautions. The acidity was determined each time by titration against a standard $\frac{N}{5}$ solution of potassium hydrate, phenol-phthallein being used as the indicator, and is expressed according to Eyre's scale. It will be remembered that the optimum reaction of culture media for *M. melitensis* has been found to be an acidity of + 10, Eyre's scale (see Part I of these reports).

Patient's name.	Date urine passed.	Acidity when passed.	Acidity on Jan. 30.	Acidity on Feb. 21.	Acidity on Mar. 29.
Anderson	Jan. 3	+ 36		+ 36	+ 26
Turner...............	3	+ 5		+ 2	− 2 alkaline
Martin...............	3	+ 44	+ 44	+ 40	+ 18
Rentcombe (*a*) ...	3	+ 60		+ 28	+ 4
,, ...	12	+ 30		+ 12	+ 12
,, (*b*) ...	15	+ 52	+ 40		
Webb (*c*)...........	Feb. 5	+ 60			+ 50
Jacombe (*d*)	5	+ 32			+ 32

In the following observations on the life of *M. melitensis* in various specimens of urine (again given in tabular form), the following was the method adopted. The specimens of urine were some healthy and some obtained from Malta Fever patients, and one of each sterilised in autoclave at 115°. In each case, after the acidity of the specimen had been determined, 10 c.c. of it were placed in a sterile test-tube with the usual wool plug. As it was also considered of importance to have information as to the number of colonies of other micro-organisms

these specimens contained, each was well shaken and one loopful, taken with a standard loop, distributed over the surface of an agar Petri dish, which was then incubated at 37°, and the number of colonies counted and recorded five days later. After the abstraction of this one loopful, each specimen was inoculated with *M. melitensis*. The same brand was placed in each, a four days' growth on glucose litmus agar of the second generation of *M. melitensis* obtained from the spleen of a fatal case (Bowles) and, as far as possible, the same amount of culture in each case, a small platinum loop being set aside for the purpose of delimiting each time the area of agar to be denuded of growth. The tubes of *M. melitensis* inoculated urine were now placed in the laboratory cupboard (temperature about 15° C.) and daily well shaken and a loopful from each plated on agar, the plate incubated for five days and then examined for *M. melitensis*, which, if found, was verified in the usual way. It was found that after a variable number of days, some morning, a plate from a given urine would contain no *M. melitensis*: this was regarded not as a sign of death of all the *M. melitensis* in the specimen, but as indicating a great diminution in number, and the daily plating persevered with till there had been a succession of seven blank days. Not infrequently a specimen would yield *M. melitensis* one day, then not yield it for one or two days and then again give it. After a succession of seven days' plating without recovery of *M. melitensis*, that particular observation was terminated with the then acidity of that particular specimen being determined and recorded.

The following were the results obtained:—

Source of urine used.	Reaction.	No. of colonies per loop.	No. of days *M. melitensis* was recovered.	Reaction of urine at end of observation.
Unsterilised, normal healthy ...	+ 7 acid	57	2	Very alkaline.
" " " ...	+ 8 "	35	5	Just neutral.
" " " ...	+ 7 "	57	2	Alkaline, strongly.
" " " ...	+ 8 "	5	33	− 5 alkaline.
Unsterilised, Malta Fever patient	+18 "	13	15	−40 "
(*a*) " " "	+60 "	32	24	−25 "
(*b*) " " "	+52 "	7	18	−25 "
" " "	+40 "	6	43	Just neutral.
(*c*) " " "	+60 "	175	36	+16 acid.
(*d*) " " "	+32 "	51	49	+ 4 "
Sterilised, normal healthy.........	+ 8 "	Nil	17	+ 2 "
Sterilised, Malta Fever patient...	+40 "	"	33	+20 "

A control inoculation of the same culture of *M. melitensis* into nutrient broth, kept under same conditions, was recovered by sub-culture on to agar after 4½ months.

Remarks.—Here neither differences in acidity or in number of other organisms seem to have had an appreciable influence on the duration of life of *M. melitensis* in urine, variations in this being presumably due to variations in other constituents so far as urine derived from Malta Fever patients is concerned, though there does seem to exist a direct connection between duration of life of *M. melitensis* and number of other organisms in the case of normal healthy urine, the greater the number of the latter the shorter the life of *M. melitensis* in such urine containing both. The urines lettered (*a*), (*b*), (*c*) and (*d*) in the two Tables I and II were identical, and the date of last determination of acidity in Table I was after the final one in Table II. The factor of difference was the presence of *M. melitensis* in urines of Table II and its absence in those of Table I, and I think the development of alkalinity in the urines of Table II compared with its non-development in the identical urines of Table I is attributable to the presence of *M. melitensis* in those of Table II, this being in accord with other observations on production of alkalinity by *M. melitensis* in nutrient media (*see* Part I of these reports).

The salient feature, however, is the comparatively long retention of reproductive activity of *M. melitensis*, lasting as long as seven weeks, in the urine of Mediterranean Fever cases. I may remark here that I find that 23 out of 30 samples of urine from Mediterranean Fever cases examined effected agglutination of *M. melitensis* in varying degrees; evidently agglutinins are excreted in the urine.

D. *Vitality of* M. melitensis *in Diluted Urine.*

1. The same brand and quantity of *M. melitensis* was placed in 1 c.c. of *fresh healthy urine*, which was well shaken and then added to 100 c.c. of sterilised tap water contained in a flask with cotton wool plug, the idea being to simulate the diluted fluid of the ordinary urinal minus accessory contaminations. Here again the flask was daily well shaken and a loopful plated on agar, the plate incubated and examined for *M. melitensis* colonies in the usual way. *M. melitensis* was recovered for nine days.

2. The same experiment was repeated, using *urine* from a *Malta Fever case*, and *M. melitensis* was recovered day by day, with occasional intervals of one, two, or three days, for 79 days; the daily sub-culture was persevered with for 14 days longer without *M. melitensis* being recovered.

Result.—1. *M. melitensis* was recovered from diluted healthy urine for nine days.

2. *M. melitensis* was recovered from diluted Mediterranean Fever urine for 79 days.

E. *Vitality of* M. melitensis *in Urine—Contaminated Milk.*

1. The same brand and quantity of *M. melitensis* was placed in 1 c.c. fresh healthy urine, which was well shaken and then added to 100 c.c. of sterilised goat's milk contained in a wool-stoppered flask, which was thoroughly well shaken every morning, and then a loopful plated on agar, incubated and examined for *M. melitensis* colonies. *M. melitensis* was recovered for three days, but after that was completely crowded out by other colonies.

2. The same experiment was repeated, using *Malta Fever urine* instead of healthy urine. In this case *M. melitensis* was recovered for 38 days.

Result.—1. *M. melitensis* recovered from milk contaminated with healthy urine for three days.

2. *M. melitensis* recovered from milk contaminated with Mediterranean Fever urine for 38 days.

F. *Vitality of* M. melitensis *in Urine Dried on Fabrics.*

The intention was here to obtain information as to the possible infectivity of garments soiled with urine containing *M. melitensis.*

1. Ten c.c. of normal healthy urine were taken and inoculated with the same brand and quantity of *M. melitensis* as in the preceding urine experiments, pieces of sterile lint were immersed in it till saturated, then removed and allowed to dry in a sterile Petri dish at the laboratory temperature (about 15° C.), which took four days. Then daily two small pieces were snipped off with sterile scissors, one put in a 10 c.c. broth tube, the other used to make impressions on the surface of agar in a Petri dish, by lifting it from area to area of the agar with a pair of forceps, and in each new situation pressing it on to the surface of the agar with a platinum spreader. The broth-tube and plate were then incubated and examined for *M. melitensis* in the usual way, but in this experiment none were recovered.

2. Precisely the same experiment, but using navy blue serge No. 3, such as is worn by the bluejacket. Again the result was the same, no *M. melitensis* was recovered.

3. Thinking that the failure to recover *M. melitensis* in the two preceding experiments might be due to the very slow drying on the fabric and the consequent facility for fermentation of the urine which certainly took place, the same experiments were repeated, using Malta Fever urine and drying the fabrics in the incubator at 37° C.; this was found to take only 24 hours instead of the four days requisite at atmospheric temperature.

Result.—*M. melitensis* was recovered from the lint so treated for five days, and from the blue navy serge for 78 days; daily sub-inoculations having been made as described in F 1. The difference between the

periods of recovery in the two cases may doubtless be attributable to the very different modes of manufacture of the two fabrics.

G. *Vitality of* M. melitensis *in Sterilised Tap Water.*

Ten c.c. of ordinary tap water were taken in a test-tube with cotton wool plug and sterilised in autoclave at 115° and then inoculated with same brand and quantity of *M. melitensis* as in the urine experiments, C 2, and placed in laboratory cupboard at temperature of about 15° C. Each day this tube was well shaken and cultured as described in C, by means of standard platinum loop and spreader on agar in Petri dishes.

Result.—*M. melitensis* was recovered for 50 days.

H. *Vitality of* M. melitensis *in Unsterile Tap Water.*

The same experiment as G, but the tap water not sterilised and two observations were made.

1. Commenced December 12, finished December 29. *M. melitensis* recovered for 10 days, tap water from rain tank on roof being used; this is not usually considered potable.

2. Commenced December 30, finished March 23. *M. melitensis* was recovered for 72 days, tap water from ordinary urban house-supply being used, which is used for drinking purposes.

Result.—1. *M. melitensis* was recovered from tank water for 10 days.

2. *M. melitensis* was recovered from potable water for 72 days.

I. *Vitality of* M. melitensis *in Unsterile Sea Water.*

This experiment was made twice in the same way as those described under G and H, the same brand and quantity of *M. melitensis* being used. The sea water was obtained from the area of the Grand Harbour in which H.M.S. "Egmont" (a stationary depôt ship on board of which a varying number of 300 to 600 men are living) is moored, and in close proximity to this ship, with the sewage of which it was demonstrably fouled.

Result.—1. The first specimen of sea water yielded three colonies per loop of other micro-organisms before inoculation, and *M. melitensis* was recovered from it after inoculation for 46 days.

2. The second specimen of sea water yielded 11 colonies per loop of other micro-organisms before inoculation, and *M. melitensis* was recovered from it after inoculation for 11 days.

J. *Vitality of* M. melitensis *Dry on Cover Slips.*

A large number of cover slips were cleaned and sterilised, an emulsion of same brand of *M. melitensis* as that used in all the preceding experiments made in sterilised distilled water, and one drop

of this placed with standard platinum loop on one surface of each cover slip, these being arranged in rows inside sterile Petri dishes wherein the drops of emulsion were allowed to dry, the whole being kept in laboratory cupboard at about 15° C. Each day one was removed with a pair of sterile forceps and placed, *M. melitensis* film-side downwards, on the surface of agar contained in a Petri dish, over which it was moved by the forceps till all the *M. melitensis* film had apparently been left distributed over the agar surface, when it was left *in situ*, still with its "film" side adhering to the agar, the cover of the Petri replaced numbered and dated, and the whole incubated for five days and then examined for growth.

Result.—M. melitensis was recovered in this way from these cover slips for 15 days; a result of some importance as showing the inherent vitality of *M. melitensis* even when dried and separated from any trace of organic matter. It will be remembered that in the dry condition on organic matter (nutrient agar) it lived for over nine months (*vide* Section B of these experiments).

K. *Vitality of* M. melitensis *in Earth.*

1. *In Sand Free from Organic Matter.*—The sand used was a silicious red sand obtained from North Africa; it was heated to redness to burn off organic matter, then well shaken with distilled water, the reaction of which was after this found to be neutral. Some of it was then sterilised in dry air at 160° C. inside a pair of watch glasses held in a clip. An emulsion of the same quantity and brand of *M. melitensis* as in preceding experiments (Second Generation from Human Spleen, Bowles) made in 5 c.c. of distilled sterilised water and well mixed with the sterilised sand, and the whole allowed to dry in a cupboard at the temperature of the laboratory, 15° C. Twice a week two specimens were put out to incubate as follows: (*a*) A little of the inoculated sand was put in a 10 c.c. broth tube which was then incubated for five days, after which a loopful was put out on a glucose-litmus-agar slope which was incubated and examined for growth; (*b*) A little was put on the surface of similar agar in a Petri dish, sufficient nutrient broth added to make a mud of it, and this was then spread out with a Klein's platinum spreader, and, after five days' incubation at 37° C., examined for growth. I found that this method gave just as constant results as the former (*a*), and it had the advantage of saving one incubation and the corresponding number of days in time.

Result.—M. melitensis was recovered in this manner for 16 days.

Remark.—This experiment and the last are quite comparable in that the *M. melitensis* culture used was not only the same, but that it was kept dry with an inorganic environment free from organic matter, and

the duration of reproductive vitality was much the same; on cover slips 15 days, in sand 16 days.

2. *In Various Malta Soils.*—In preliminary experimentation on the sterilisation of these, they were all found after sterilisation by dry heat to be excessively alkaline, a condition seriously prejudicial to the vitality of *M. melitensis.* This was found to be due to the large amount of calcium carbonate they contained, some of which, by the dry heat used, was converted into calcium oxide, which on the addition of water became calcium hydrate. This caused one to examine the reaction of the various soils as received, by thoroughly stirring up and shaking each, and then shaking a little in distilled water in a test-tube and taking the reaction of that. All the specimens were thus found to be slightly alkaline to begin with. So sterilisation was now done by putting the specimen of soil in a beaker, half filling this with distilled water and placing it in the autoclave at 115° for 30 minutes; this was found to effect sterilisation without any alteration of alkalinity.

(a) *In Greyish Yellow Soil, with additional Organic Matter.*

This soil was personally obtained from a field in Sliema, was sterilised as just described, sterility verified by broth culture, a portion in bulk equal to about 10 c.c. placed in a sterile test-tube and put in incubator at 37° C. till dry, then on to it was poured, by means of a sterile pipette, a broth growth of *M. melitensis* (still Second Generation from Human Spleen, Bowles), till its upper $\frac{1}{3}$ was quite saturated with moisture, then tube was plugged with sterile wool and placed in laboratory cupboard. Twice in each week two portions from the upper surface were planted out in the manner described in K 1 for sand, incubated, and examined for growth. It was noticed, as the experiment progressed, that the upper surface of the soil got apparently dry, but that at the bottom of the test-tube it became damp from percolation of the nutrient broth downwards, and this dampness persisted till the conclusion of the experiment; so that the *M. melitensis* present must have been continually in the presence of water vapour. As in K 1, it was found that planting out on agar, as described, gave just as constant results as planting out in broth and then sub-culturing from this.

Result.—*M. melitensis* was thus recovered from this soil for 91 days.

(b) *In Reddish Soil without additional Organic Matter.*

This soil was also personally obtained from a Sliema field; it was very similar in composition to that used in the preceding experiment, differing mainly by containing a little under 1 per cent. of iron oxide, to which its reddish colour was due. It was sterilised under water in the autoclave at 115° C., sterility verified by broth culture, and sufficient placed in a small sterile Petri dish (3 cm. in diameter) to give a depth of about $\frac{3}{16}$ to $\frac{1}{4}$

of an inch. An emulsion of same quantity and brand of *M. melitensis* as in Experiment K 1 was made in 5 c.c. of distilled sterilised water, and, by means of a sterile pipette, was distributed all over the surface of the sterilised soil contained in the Petri dish. Two small portions of this were planted out in agar and in broth twice weekly in the manner already described, incubated and examined for growth.

Result.—*M. melitensis* was thus recovered from this soil for 80 days.

(c) *In White Soil without additional Organic Matter.*

This specimen of soil was obtained from an area of land where building operations were going on, and consisted very largely of the *débris* from the stone cutting, shaping, and smoothing operations which, as is usual in Malta, were carried out on the spot where the finished stone was wanted for use. It is a very soft friable Globigerina limestone, and the *débris* used contained only a mere trace of organic matter. With this the experiment just described was exactly repeated in every particular.

Result.—*M. melitensis* was recovered for 24 days.

(d) *In Recently well-manured Soil, Sterilised and kept Wet.*

This experiment was intended to contrast with the latter in the amount of organic matter present in the soil, it being very great in this experiment, very little indeed in the last one, and also in the amount of water present, a similar difference being maintained. Recently (five weeks) manured soil was obtained from the Argotti Botanical Gardens, dried, pulverised in a mortar, sterilised as in the preceding three experiments, an amount equal in bulk to about 10 c.c. put in a sterile test-tube and well shaken down; and then on to it was poured, by means of a sterile pipette, an emulsion of *M. melitensis* grown on agar made from the same quantity, brand, and generation of *M. melitensis* as in the preceding experiments, in 5 c.c. of distilled sterilised water. This soil was further kept saturated with moisture by dropping on it from time to time sterilised tap water from a sterile pipette, and was kept at laboratory temperature (15° C.) for the whole period of the experiment. From it two portions were planted out in broth, and on agar twice weekly in the way described in K 1, then incubated and examined for growth. The experiment was started on December 14, 1904, and each planting out yielded *M. melitensis*, which, as usual, was duly verified. During the examination and verification of the growth of January 8, it was noticed that the resulting colonies, while resembling the usual *M. melitensis* colony in every other particular, had less sharply defined, less abrupt margins, and that the microscopical preparations contained a few bacillary forms. By February 12 the new colonies of that date presented slightly crenated edges, shading away on the agar, though quite similar in size and shape

to standard *M. melitensis* colonies of same duration of growth on same agar, and now consisted almost entirely under the microscope of small bacillary forms, when stained, of about $\frac{2}{3}$ the diameter of a normal *M. melitensis*, and three times its length. A sub-culture of this was now put through *all* the tests specified in Part I of these Reports, for the recognition and verification of *M. melitensis*, behaving in all particulars like standard *M. melitensis* save in the morphological details mentioned. These bacilli in hanging-drop preparations were feebly motile. Many specimens were stained for flagellæ according to Rossi's method, but none were demonstrated. It will be remembered that Gordon, in a paper in the *Lancet*, March 11, 1899, described flagellæ in connection with *M. melitensis*. I have not succeeded in verifying this. Successive sub-cultures of this growth of February 12, for 10 generations, in broth and on agar were now made, but there was no reversion to the coccal form; the Tenth Generation was exactly like the First; but a sub-culture from the Ninth Generation into peptone water (made for the purpose of ascertaining the presence or absence of indol and nitrite formation, neither present), showed in a stained specimen both cocci and bacilli, and intermediary forms such as French bacteriologists speak of as "cocco-bacille." On February 22 a rabbit which had never been experimented upon, and whose blood gave no trace of agglutination with standard *M. melitensis*, was injected intra-cerebrally with the usual aseptic precaution with $\frac{1}{2}$ c.c. of an emulsion made from this same Ninth Generation. Its temperature rose to 105° F. the same evening and 106° F. the following evening, after which it fell to normal and never rose again. On February 25 there was a distinct agglutination reaction on *M. melitensis*, with its blood serum in a dilution of $\frac{1}{32}$; this had increased on March 5 to a dilution of $\frac{1}{300}$. On February 28 1 c.c. of blood was taken aseptically from the animal's left internal saphenous vein, placed in 19 c.c. of nutrient broth, and incubated in the usual way. There being absolutely no trace of growth obtainable from this up to March 10, the animal, which had fully recovered from the operation, was that day chloroformed, a *post-mortem* made, and inoculations made into both broth and agar from the brain, heart's blood, urine, spleen, liver, and kidneys; no growth was obtained from any of these.

Concurrently with all this, the periodical plantings out had been carried on, but no growth was obtained from any planting out later than March 7, though these were continued till March 22.

Remarks.—A bacillary form in pure cultures of *M. melitensis* has been noticed by various workers, but not apparently in so marked a degree as in this instance. As an intra-cerebral injection of the coccal form of *M. melitensis* usually produces in a rabbit death in four or five days with presence of *M. melitensis* in the various organs, the bacillary form produced, as described, is obviously of less virulence.

Result.—M. melitensis was recovered from this sterilised, manured, and saturated soil rich in organic matter for 83 days, a bacillary form of *M. melitensis* deficient in virulence being developed.

(e) *In Recently Manured Non-Sterilised Soil.*

The same soil as in the last experiment was used and treated in precisely the same way save that it was not sterilised.

As it was anticipated that very rapid overgrowing of the *M. melitensis* put in (the viability of which was as usual tested by a control) would take place, a little was planted out daily, a small portion being placed on the surface of agar in a Petri dish, made into mud with nutrient broth, and distributed by means of a Klein's platinum spreader all over the surface of agar in three successive Petri plates. Although in this manner discrete isolated colonies were obtained in the third plate, no *M. melitensis* was ever recovered, though four separate repetitions of the experiment were made.

Result.—M. melitensis speedily crowded out by the other organisms present.

Summary of Results obtained as to Vitality of M. Melitensis *Outside the Body, the same Brand, Generation and Quantity of* M. melitensis *being used throughout* (*except in* B 1).

	Days.
A. In mixed broth culture with—	
1. Laboratory contamination	7
2. " "	7
3. Organisms derived from sweat, skin and urine	2
4. " " " "	Nil
5 to 10. " " " " and breath; in each	1
B. In pure culture media with a reaction of + 10 acid—	
1. On agar slope (source of *M. melitensis* not noted)	276
2. In litmus milk (source of *M. melitensis* as in all other experiments)	144
3. In peptone broth (ditto)	173
C. In urine (persistent acidity of Mediterranean Fever urine as described)—	
1. In unsterilised normal healthy urine, four experiments	2, 5, 2 and 33
2. " " Malta Fever urine, six experiments	15, 24, 18 43, 36 and 49
3. " sterilised normal healthy urine, one experiment	17
4. " " Malta Fever urine, one experiment	33

		Days.
D. In diluted urine—		
	1. Healthy urine diluted 100 times with sterile tap water	9
	2. Mediterranean Fever (ditto)	79
E. In urine contaminated milk—		
	1. Goat's milk contaminated with 1 per cent. healthy urine	3
	2. " " 1 " Mediterranean Fever urine	38
F. In urine dried on fabrics—		
	1. In Mediterranean Fever urine dried on lint	5
	2. " " " navy serge	78
G. In sterilised tap water		50
H. In unsterilised tap water—		
	1. Tank water	10
	2. Potable water	72
I. In unsterile sea water, two experiments		11 and 46
J. Dry on cover slips		15
K. In various earths—		
	1. In sand free from organic matter	16
	2. " various Malta soils—	
	a. In sterilised grey-yellow soil with added organic matter	91
	b. In sterilised reddish soil without added organic matter	80
	c. In sterilised white soil almost free from organic matter	24
	d. In sterilised well-manured soil rich in organic matter (bacillary forms of *M. melitensis* developed)	83
	e. In non-sterilised well-manured soil	Not recovered

IV. ON THE RECOVERY OF *MICROCOCCUS MELITENSIS* FROM THE URINE OF MEDITERRANEAN FEVER PATIENTS.

By J. Crawford Kennedy, Captain R.A.M.C., Member Mediterranean Fever Commission, Malta, April, 1905.

Since September, 1904, this work has been more than trebled, and special attention has been paid to the quantities excreted and to the period of disease during which the excretion is greatest.

The following table is a summary of the work done :—

	No. of samples examined.	No. of times *M. melitensis* recovered.
September	347	6
October	217	6
November	581	63
December	398	43
January	201	19
February...............	110	19
March to April 2 ...	120	30
Total	1974	186

Percentage of recoveries...... 9½ per cent.

The number of cases examined was 61, and from 33 of these *M. melitensis* was recovered. Therefore *M. melitensis* was recovered from 54 per cent. of the cases examined. Deduct from this the cases which were examined less than 10 times—it leaves 50 cases and 31 recoveries, or 62 per cent.; 43 cases were examined over 20 times, with 31 recoveries, or 72 per cent.

The method of examination was the same as described by Major Horrocks in a former report, and each recovery put through the usual tests.

In order that the work may be taken in at a glance, I have prepared a list of the cases from which *M. melitensis* was recovered, giving particulars of number of samples and recoveries, quantity and period of disease, also a chart of the temperature. In those cases which supplied many recoveries the whole chart is given, in those with only one recovery, only the previous and subsequent two or three days' temperature is given.

List of Cases from which *M. melitensis* has been Recovered, giving particulars of Quantity and Period of Disease.

No.	Name.	No. of samples examined.	No. of times *M. melitensis* recovered.	Greatest No. of colonies *M. melitensis* found in a cubic centimetre urine.	No. of times *M. melitensis* recovered when temperature of previous or of subsequent 24 hours not above 99°.	Earliest and latest day of illness on which *M. melitensis* recovered.	Remarks.
1	Kinsella	97	27	189	16	21 111	See chart. This case examined all through illness. The excretion of *M. melitensis* was almost entirely during convalescence.
2	Bean	44	23	450	7	58 84	See chart. A normal temperature for 7 days during excretion of *M. melitensis*.
3	Ralph	76	18	440	2	39 133	See chart. Excretion of *M. melitensis* after 33 days' normal temperature.
4	Smith (Rifles)	64	6	309	—	74 114	See chart.
5	Gane	29	14	1068	7	108 145	See chart. Excretion after 27 days of practically normal temperature.
6	Charlton	35	4	18	4	82 102	See chart. Excretion after 30 days' normal temperature.
7	Bolt	151	23	129	—	74 165	See complete chart.
8	Anthony	91	3	Innumerable	—	81 156	See chart. Colonies so thick in one sample as to be uncountable—from 500 to 800 in one drop urine.
9	Surmin	93 (74 days)	48 (41 days)	Innumerable	27	174 249	See chart. Another case of a sudden gush of *M. melitensis* in urine.
10	Groom	70	1	3	1	82	See chart.
11	Mitchell	4	1	6	1	77	See chart. Excretion after 12 days' normal temperature.
12	Rivers	4	1	3	1	43	See chart.
13	Cannole	31	2	3	2	102 112	See chart. Excretion after 15 days' normal temperature.

List of Cases from which *M. melitensis* has been Recovered, giving particulars of Quantity and Period of Disease—*contd.*

No.	Name.	No. of samples examined.	No. of times *M. melitensis* recovered.	Greatest No. of colonies *M. melitensis* found in a cubic centimetre urine.	No. of times *M. melitensis* recovered when temperature of previous or of subsequent 24 hours not above 99°.	Earliest and latest day of illness on which *M. melitensis* recovered.	Remarks.
14	Campbell	71	2	6	—	93 94	See chart.
15	Walker	25	2	116	—	55 56	See chart.
16	Silburn	23	2	9	2	60 65	See chart. Excretion during convalescence.
17	Turner	80	1	3	—	52	See chart.
18	Bagwell.........	29	1	3	—	77	See chart.
19	Rentcome	40	1	4	1	99	See chart.
20	Marchant	55	1	15	—	72	See chart.
21	Donovan	46	1	3	1	57	See chart.
22	Bennett.........	41	1	4	1	83	Excretion after 24 days' normal temperature; quite convalescent.
	Total	1199	183	Earliest day recovered		21	Out of 20 cases examined during convalescence 11 were found to be excreting *M. melitensis.*
				Latest day recovered		249	
	Average...	—	15·2 per cent.				

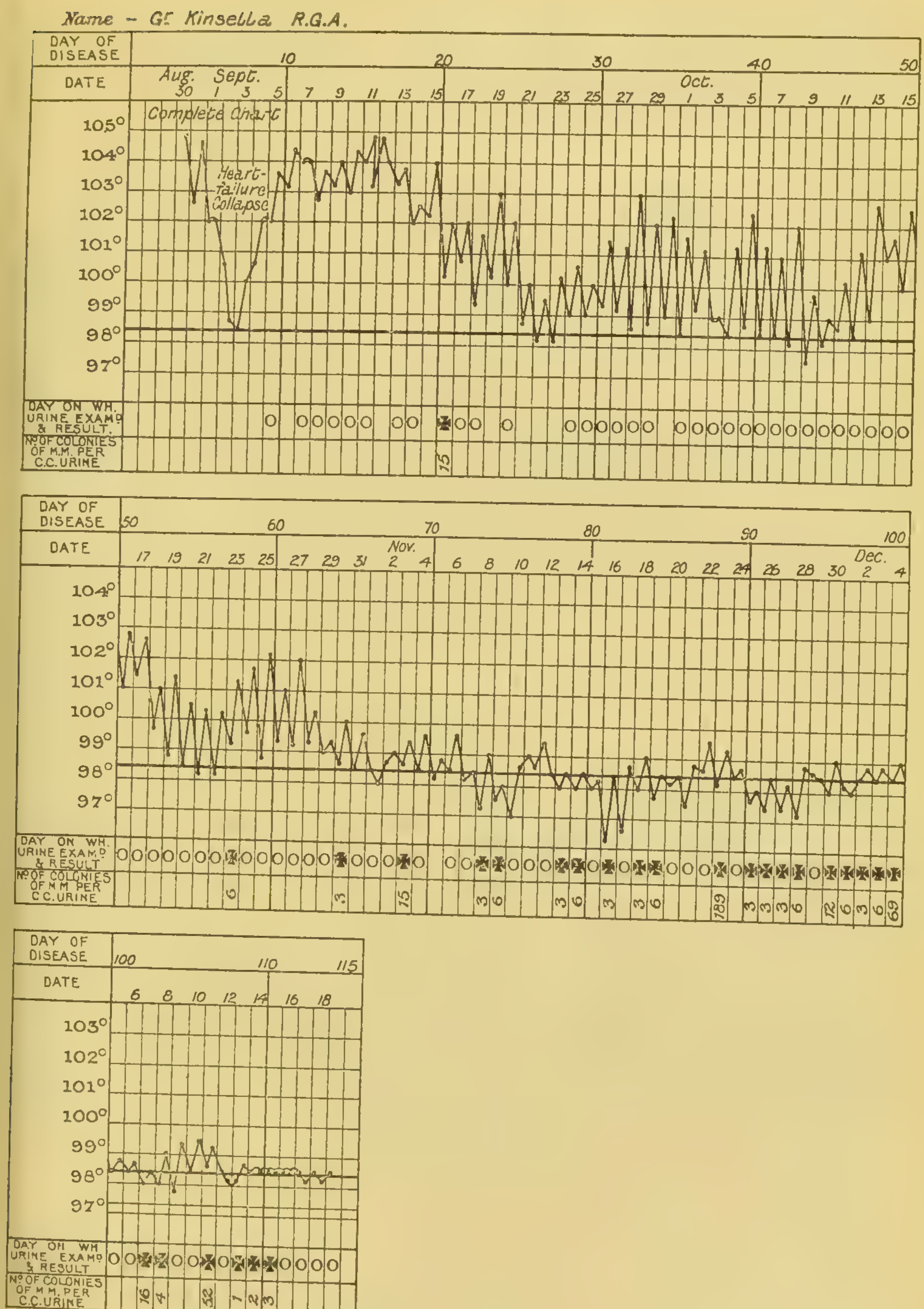


Chart 1.—KINSELLA.

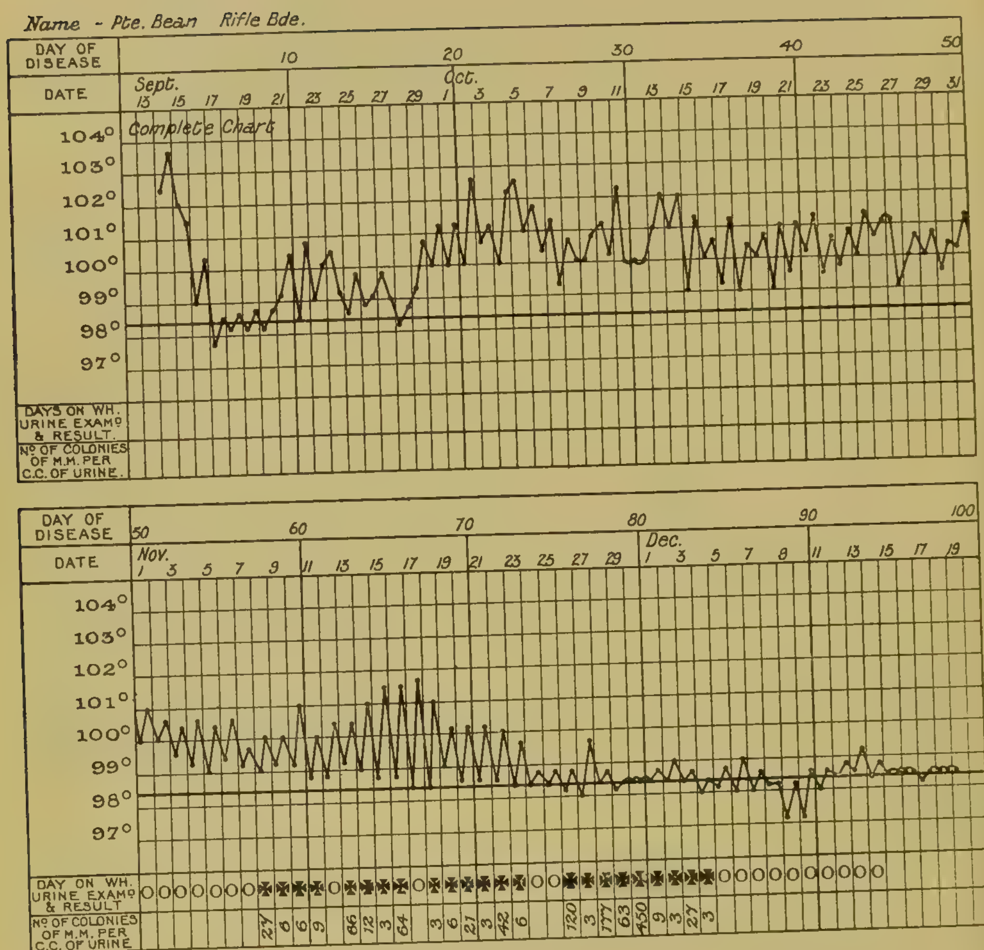

Name - Pte. Bean Rifle Bde.
DAY OF DISEASE
DATE
Sept.
Oct.
Complete Chart
DAYS ON WH. URINE EXAMº & RESULT.
Nº OF COLONIES OF M.M. PER C.C. OF URINE.
Nov.
Dec.

Chart 2.—BEAN.

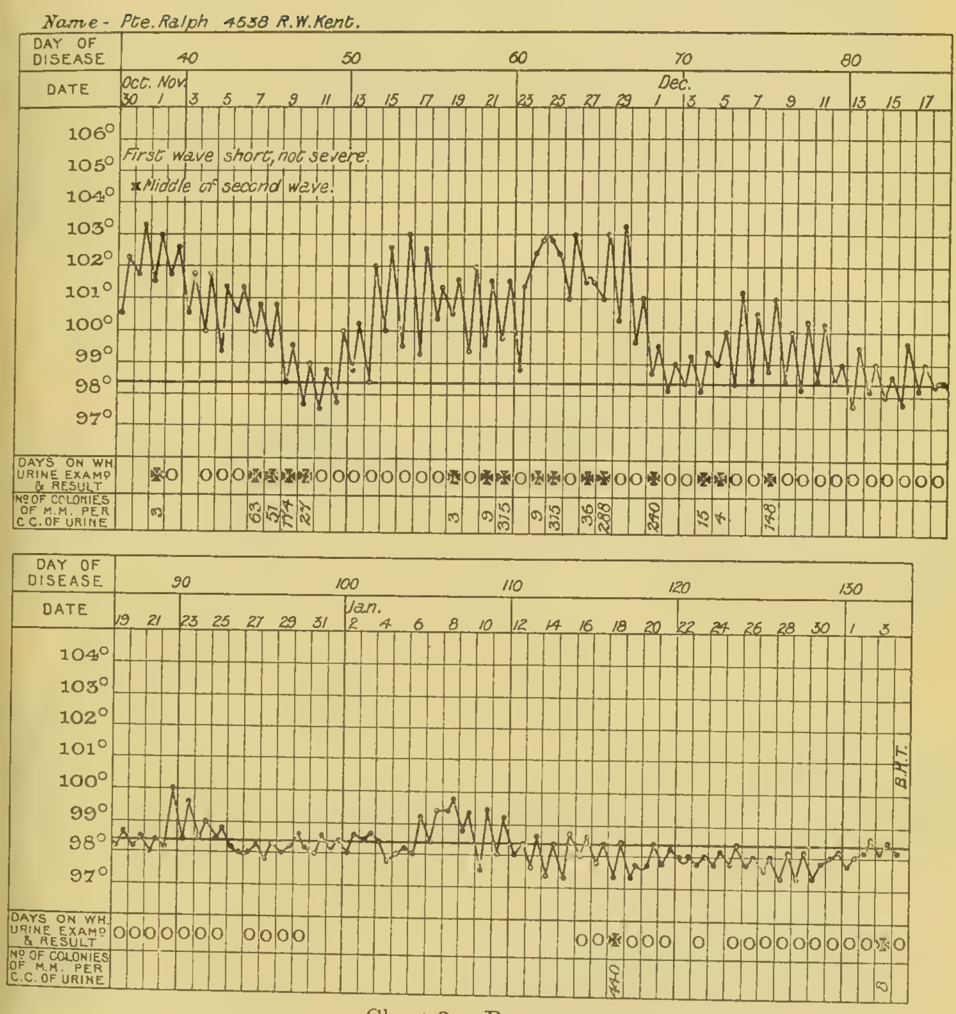


Chart 3.—Ralph.

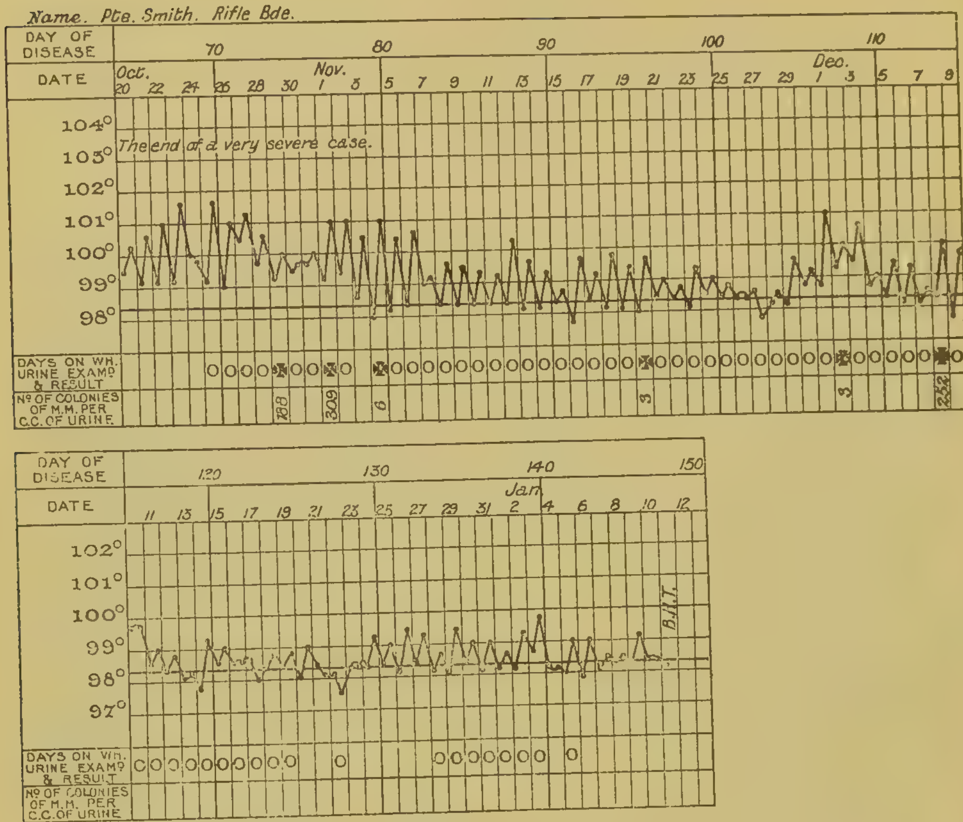


Chart 4.—SMITH.

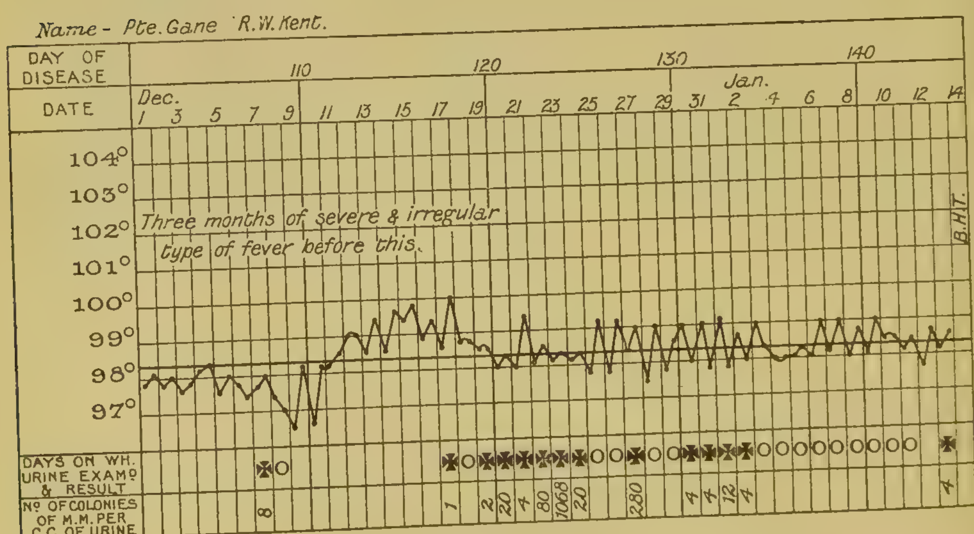


Chart 5.—GANE.

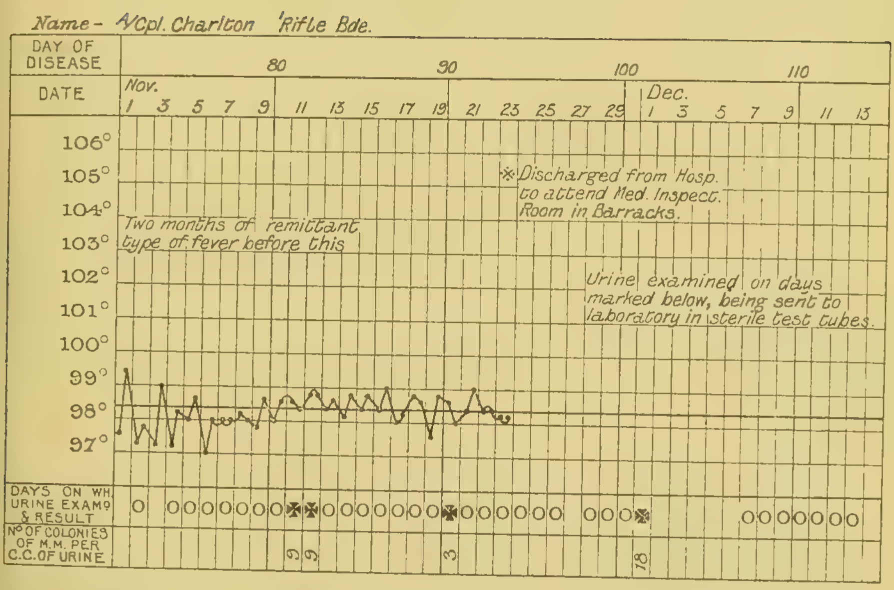


Chart 6.—CHARLTON.

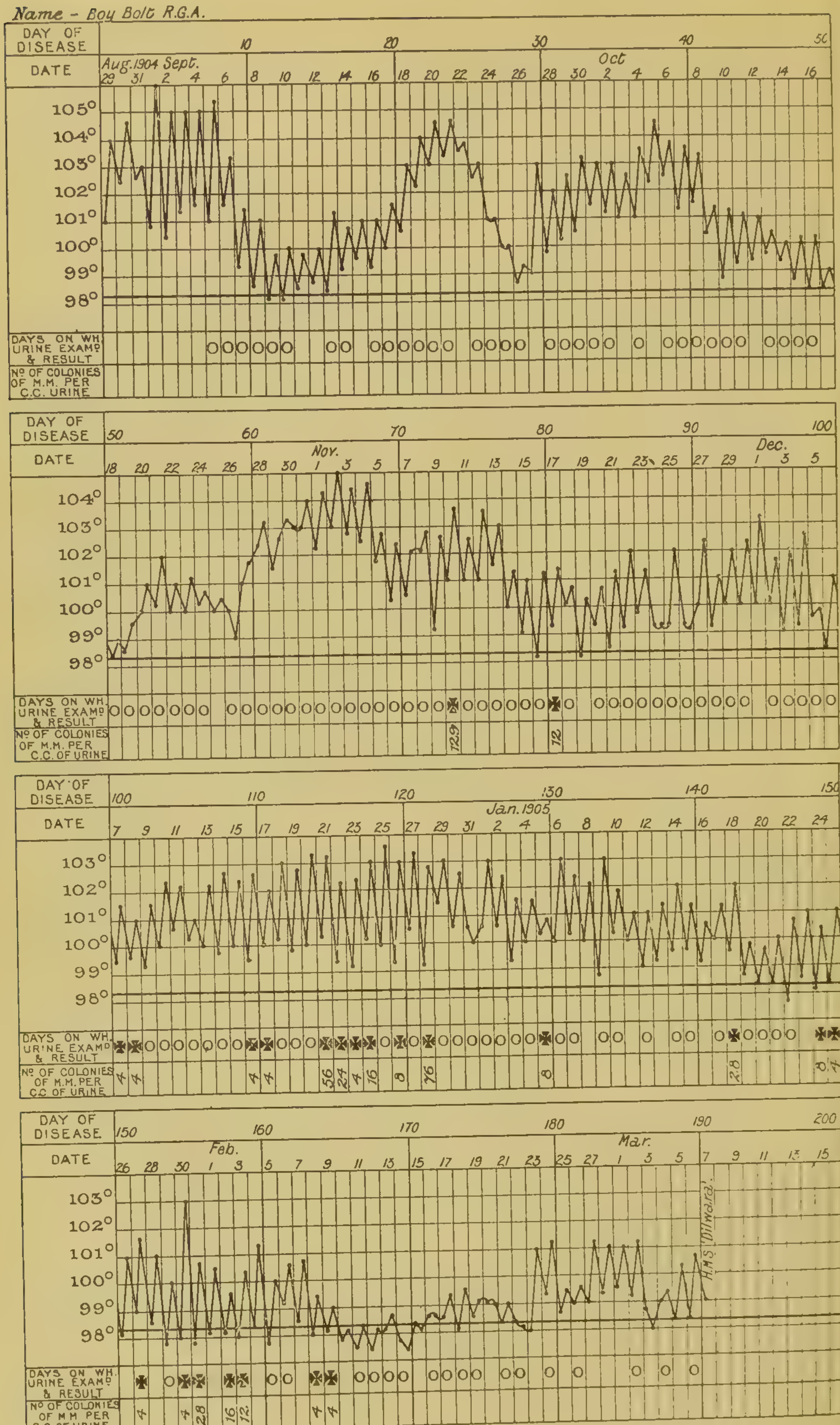
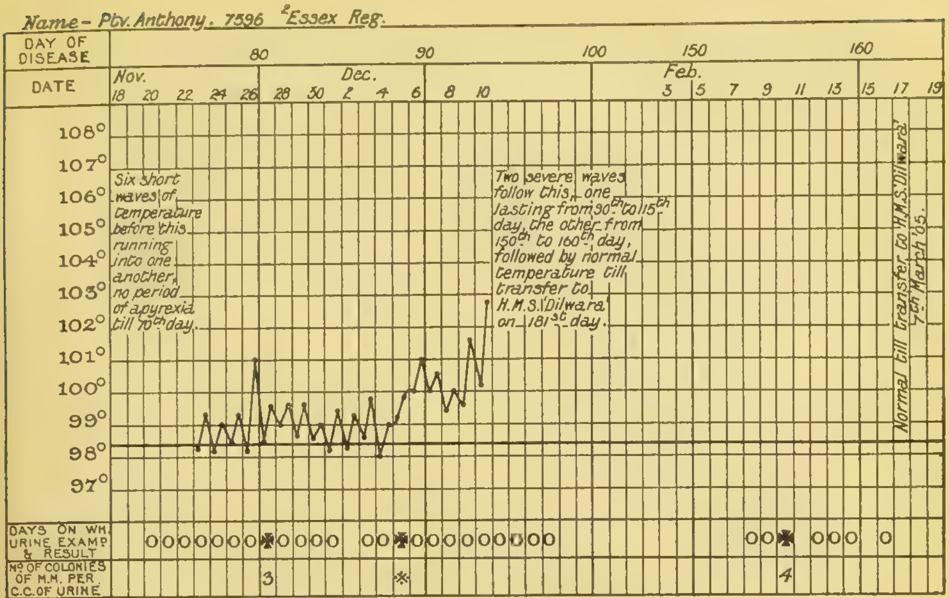
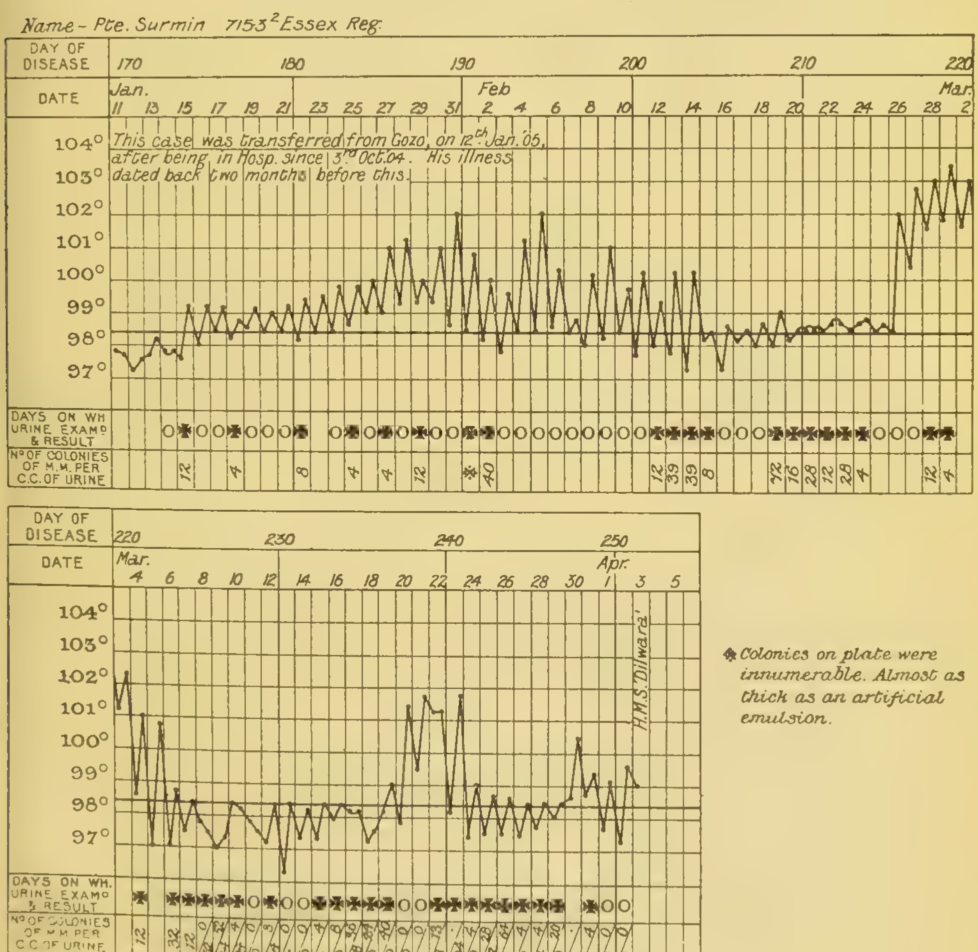

Name - Boy Bolt R.G.A.
DAY OF DISEASE
DATE
Aug. 1904 Sept.
Oct
Nov.
Dec.
Jan. 1905
Feb.
Mar.
105°
104°
103°
102°
101°
100°
99°
98°
DAYS ON WH. URINE EXAMº & RESULT
Nº OF COLONIES OF M.M. PER C.C. URINE
H.M.S. 'Dilwara'.

Chart 7.—Bolt.



※ Colonies absolutely innumerable, any number between 500 to 800 in each drop of urine.

Chart 8.—ANTHONY.



※ Colonies on plate were innumerable. Almost as thick as an artificial emulsion.

Chart 9.—SURMIN.

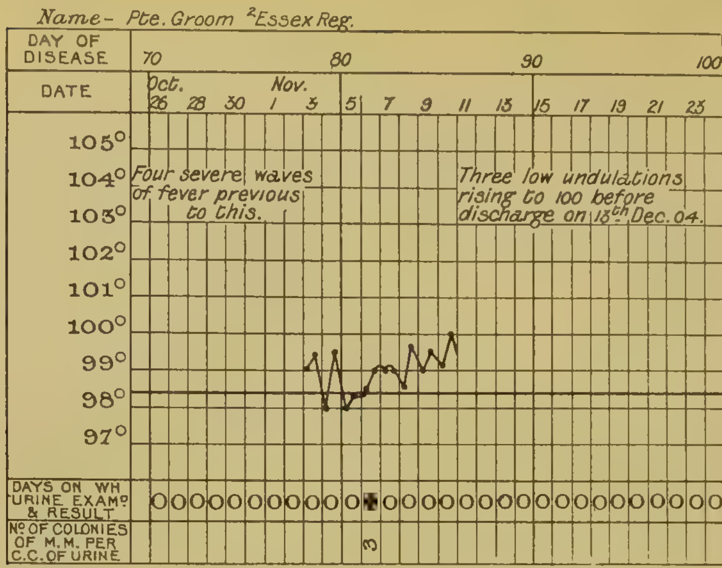


Chart 10.—Groom.

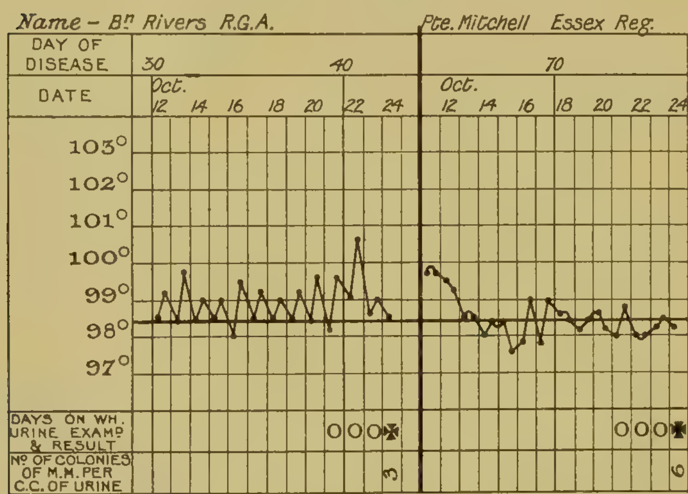


Chart 12.—Rivers. Chart 11.—Mitchell.

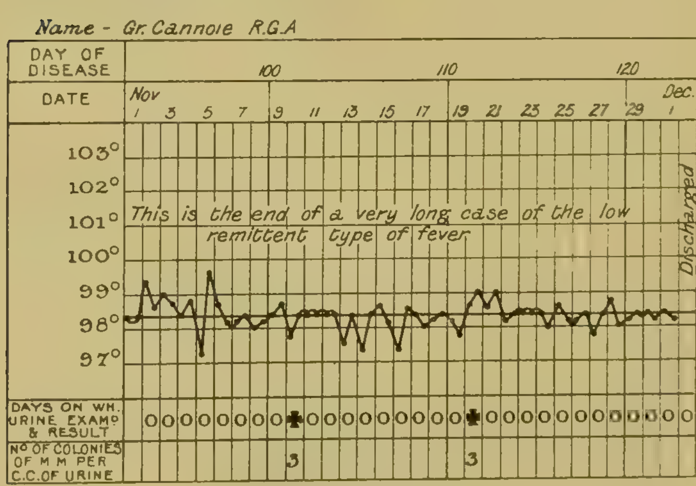


Chart 13.—Cannole.

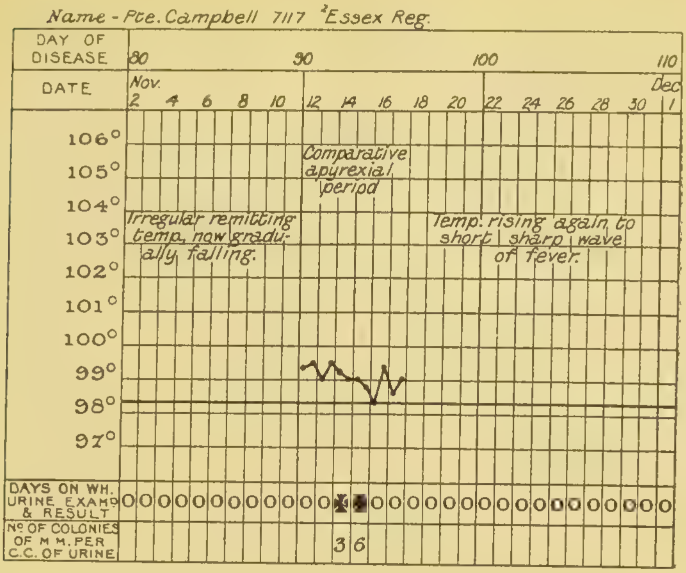


Chart 14.—CAMPBELL.

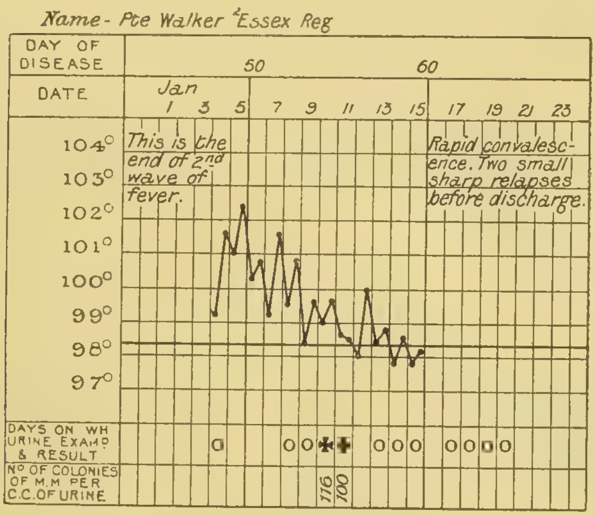


Chart 15.—WALKER.

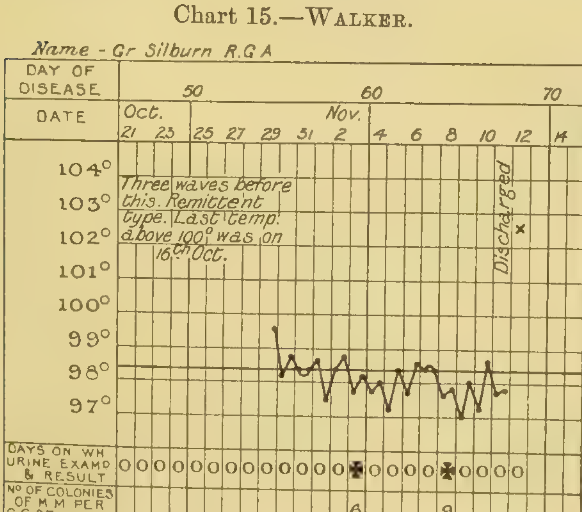


Chart 16.—SILBURN.

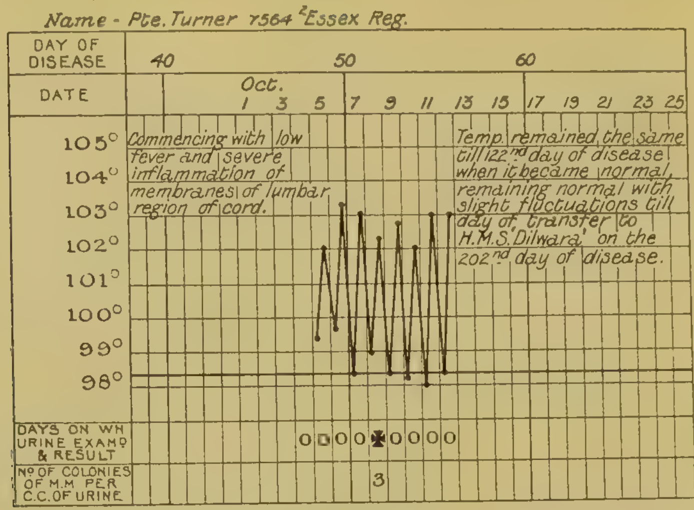


Chart 17.—TURNER.

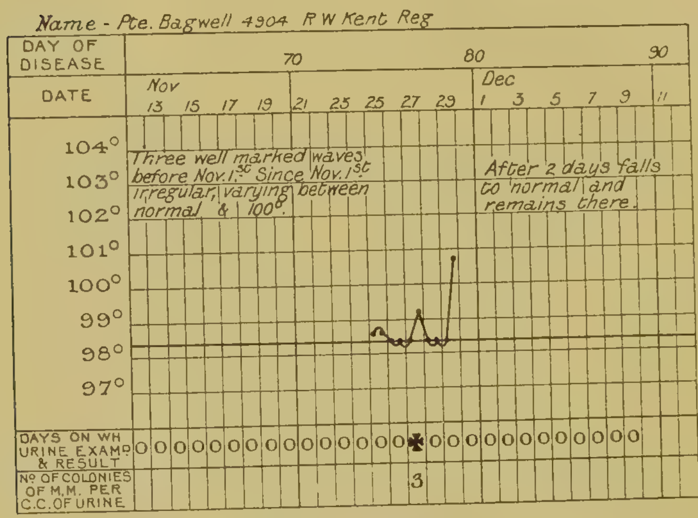


Chart 18.—BAGWELL.

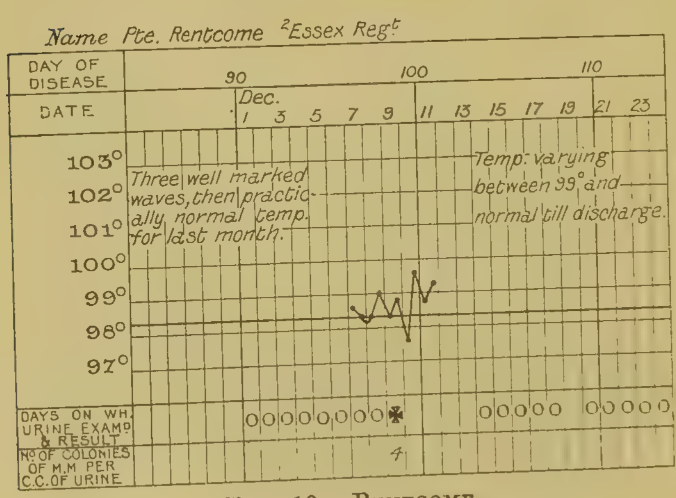


Chart 19.—RENTCOME.

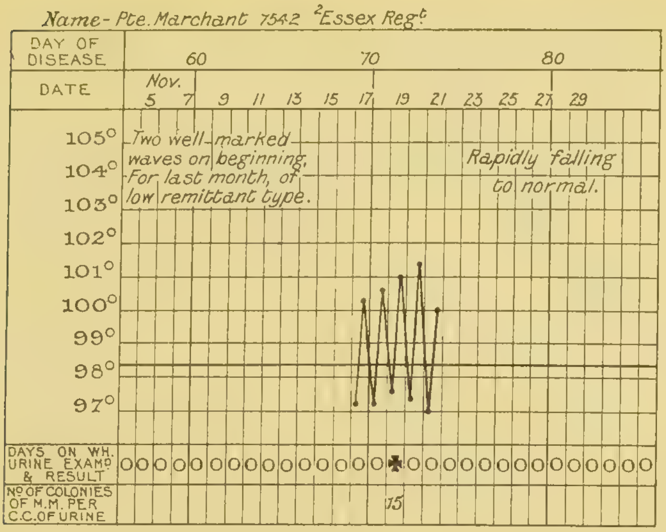


Chart 20.—MARCHANT.

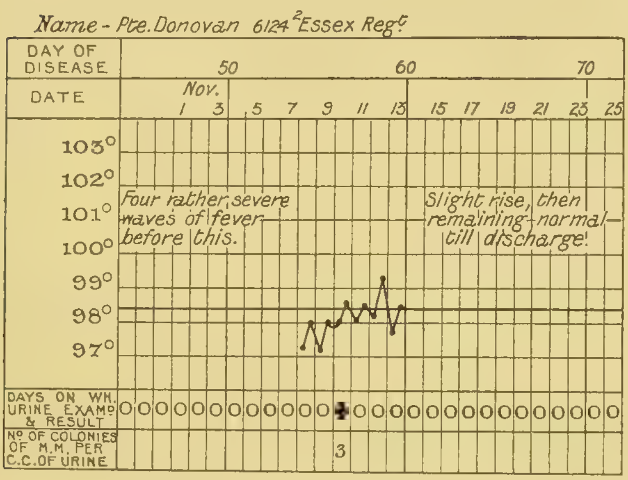


Chart 21.—DONOVAN.

Summary.—The excretion of *M. melitensis* in the urine would appear to be of two kinds :—

(1) A sudden enormous gush which stops as suddenly as it appears.

(2) A long continued excretion of small quantities.

As examples of the first see Cases Nos. 8 and 9.

As examples of the second see Cases Nos. 1, 2, 5, 7 and 9.

The period of disease most favoured is early convalescence or the last stages of the fever, especially just as a "wave" of fever is subsiding and the temperature reaching normal. It will be noticed that excretion tends to stop if another "wave" begins (see Charts 3, 8 and 9).

The time of day or rather the period of the 24 hours during which

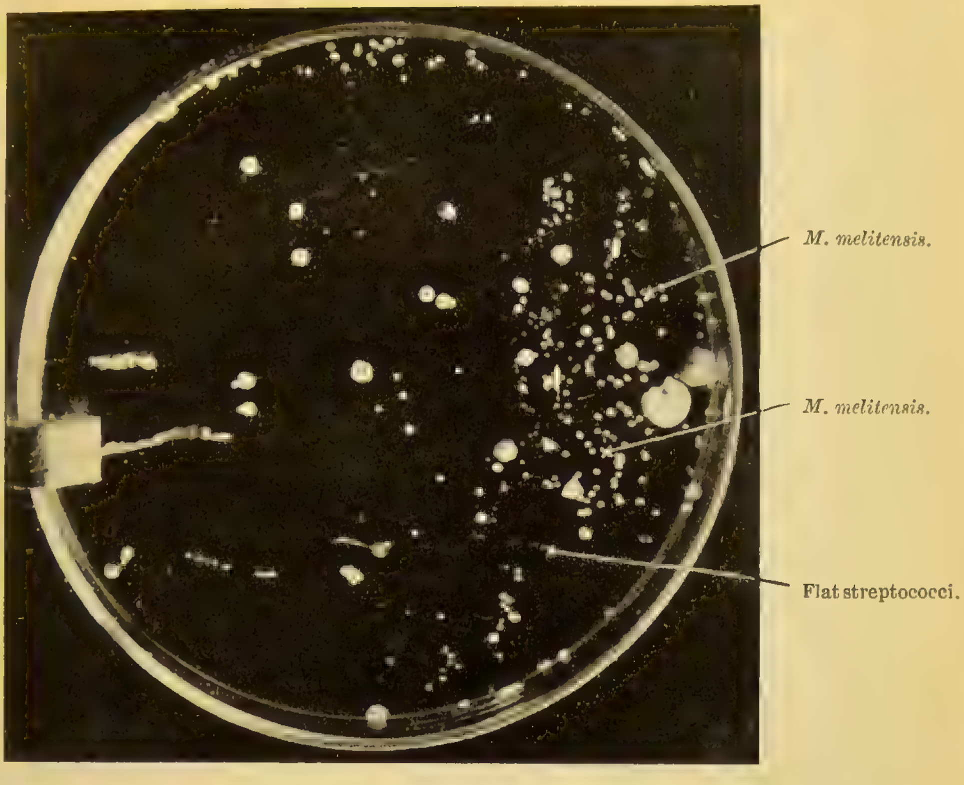
the excretion is greatest, appears to be between 6 P.M. and 6 A.M. Case No. 9 was for some time examined morning and evening, viz., the urine passed at 6 A.M. and that passed at 6 P.M. On 14 days on which the urine was examined at both these times *M. melitensis* was recovered, and taking the average daily excretion for the morning and evening it was found to be 20 colonies per cubic centimetre for the morning to 14 for the evening. On the 14 days mentioned above, *M. melitensis* was found 13 times in the morning urine and only eight times in the evening (see Chart).

The length of time after recovery during which the excretion may continue appears to be considerable, see Cases Nos. 3, 5 and 6. In the case of No. 6, the patient was discharged from hospital cured, but with orders to attend daily at the Medical Inspection room. I supplied him with sterile test-tubes and he daily supplied me with a fresh sample of his morning urine; on the seventh day after his discharge I found six colonies per $\frac{1}{3}$ c.c.

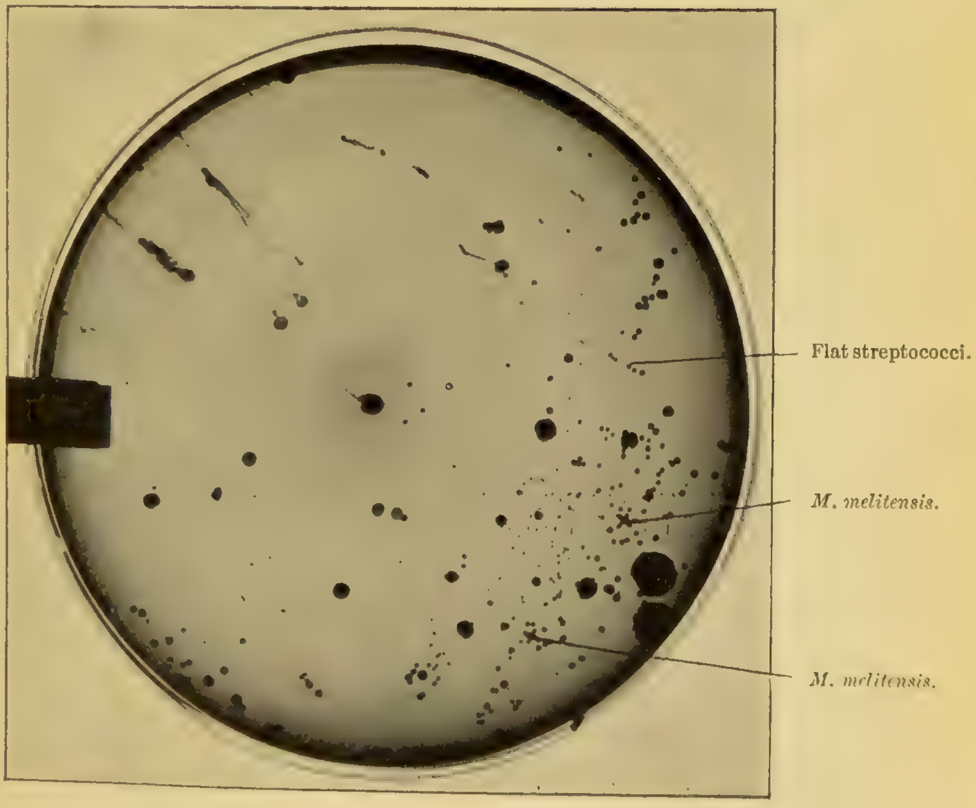
The longest period (temperature not above 99) after which excretion has been proved is 33 days; but see Case No. 1, where from the 66th day to the 111th day temperature never reached 100, yet *M. melitensis* was recovered all this time. There were, however, slight periodical rises to 99°·4, indicating the presence of infection in the system.

The most severe and prolonged cases were the ones that provided the most recoveries. The latest day of disease on which *M. melitensis* was recovered was the 249th.

I attach the photographs of a plate made by planting out $\frac{1}{4}$ c.c. of urine and incubating for four days. I tried to bring out the globular pearly white appearance of the colonies, and found it could best be done by using reflected light and a dark background. See also photographs of Surmin, February 1, further on.



Reflected light.



Direct light (same plate).

V. ON THE VITALITY OF *MICROCOCCUS MELITENSIS* IN URINE (in which it has been excreted), ON CLOTH, IN DUST, STERILE TAP WATER, AND STERILE MILK.

(Being Experiments 1 to 6, suggested by the Sub-Committee.)

By J. Crawford Kennedy, Capt. R.A.M.C., Member Mediterranean Fever Commission. Malta, April, 1905.

Experiments 1 *and* 2.

How long does the *M. melitensis* retain its vitality in urine?

The following procedure was adopted:—A batch of urines was collected every day in sterile test-tubes plugged with cotton wool, and after ¼ c.c. from each had been planted out on plates they were laid aside. The next day, and every day till the 4th day, ¼ c.c. was again planted out on Petrie dishes. On the 4th day the plates made on the 1st day were sufficiently incubated, and the presence or absence of *M. melitensis* was noted. Those urines from which *M. melitensis* was absent were then discarded.

It was soon found that *M. melitensis* could be recovered after four days in urine, so the urines were left undisturbed for the four days until it was determined which samples contained *M. melitensis.* Those samples were then plated out day after day, the more plates being used each day according to the length of time the urine had been kept.

As the majority of the samples contained *M. melitensis* in very small quantities, the urine was disturbed as little as possible, so that, supposing the *M. melitensis* had been found in one sample on the 5th day, the next sample of urine was not plated out till the 6th day, and so on. In this way 525 samples of urine were gone through. In 53 of these *M. melitensis* was recovered in the first instance, but in only 12 was it recovered a second time.

The following table (p. 72) shows at a glance the result of the examination of these 12 samples.

The *M. melitensis* has therefore been recovered from urine 16 days old. The points that favour its existence in urine are—

1. Acidity,
2. Absence of other organisms, whether acid or alkaline.

1. The urine of Mediterranean Fever patients is markedly acid, and if moderately free from contaminating germs will remain so for a

Date.	Name.	Number of colonies of *M. melitensis* found on 1st day per plate.	Result of examination of urine after standing the number of days indicated. + = *M. melitensis* recovered.																						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Dec. 7	Kinsella ...	4	+	0	0	0	0	0	0																
17	Bolt.........	1		0	+	0	0	0	0																
20	Gane	5			+	+		0	0	0	0														
21	Gane	1			+		+	+	+	0	0	0	0												
	Bolt.........	14			+		0	0	0	0	0														
27	Gane	70 A				+	0	0	0	0	0	0													
		B						0	+	0	0	0													
		C							+	0	+	0			0										
31	Gane	1						+	+			+	+		0		0								
Jan. 1	Gane	3						+		0	0	0		+				+			0				
10	Walker ...	29 (alkaline)						+		0		0													
13	Gane	1													+	+	0	0	0	0					
Feb. 1	Surmin ...	—			+			0										+						0	
13	Surmin ...	13	+	0	+	+	+	+	+	0	+	+	+	+	+	+	0	+	0	0	0			0	

very long time. Both the urines in which *M. melitensis* was recovered on the 16th day were acid on that day. The urine of Gane remained acid 29 days.

Two other samples (Kinsella, December 7 and 11, 1904) were tested daily for acidity to litmus; the sample of December 7 began to turn alkaline on January 27, and the other on January 26—*i.e.*, 51 and 46 days respectively. At the same time these samples, when planted out on plates, were found to be very filthy by the 5th or 6th day.

In only one sample was *M. melitensis* recovered, when the urine gave an alkaline reaction—viz., Walker sample, January 10. This urine was alkaline on the 1st day, and *M. melitensis* was recovered after it had stood for six days.

2. The presence of other organisms in the urine in any quantity is fatal to the recovery of *M. melitensis.* I am inclined to think that it may exist alongside the others, but that on nutrient media the excessive acidity or alkalinity produced by these rapid growing organisms prevents its development.

On several occasions I have found colonies of *M. melitensis* in a very acid plate hiding under the shelter (as it were) of a large alkali producing colony, where the acid is neutralised by the alkali.

Colonies that grow under these difficulties are always very tiny, do not have the amber colour by transmitted light, and in salt solution tend to remain in chains; the subcultures, however, are typical.

The sample of Surmin, February 1, was one of the two which contained *M. melitensis* in enormous quantities, and should have been an excellent sample for this experiment. *M. melitensis* was easily recovered from it on the 3rd day, but could not be isolated on the 6th, as the plate was overgrown with acid streptococci.

I attach a photograph (Plate 2) of the plates made from this sample on the 1st and on the 3rd day. It will be noticed that they are practically pure cultures of *M. melitensis.* The second plate is not so vigorous a growth as the first, the colonies tend to be smaller and less well defined, though their number is just as great as in the first. Both were incubated for four days. I have taken them in such a way that the light is reflected from the surface of the colonies, which thus stand out in relief.

Experiment with Artificially Infected Urine.

On December 16, 1904, the *M. melitensis* from the urine of a patient was added to the freshly passed urine of another, until the urine became cloudy. This was allowed to stand in a sterile test tube plugged with cotton-wool.

M. melitensis was easily recovered up to December 22 (six days). On the 23rd the growth of *M. melitensis* on the plate was beginning to get faint.

On the 24th the growth of *M. melitensis* was merely a faint blue haze along the edge of the track left by the drops of urine as they ran over the plate.

On the 26th *M. melitensis* could not be recovered as the plates were quite overgrown with acid streptococci. The urine remained acid for six days, after when the experiment was stopped.

Results.—The *M. melitensis* retains its vitality in urine (naturally infected) for 16 days, provided the urine remains acid and is fairly free from contaminating organisms.

It has been isolated from a urine (naturally infected) which had turned alkaline after six days.

In an artificially infected urine *M. melitensis* retained its vitality for seven days.

Experiments 3, 4, 5 *and* 6. *Suggested by the Sub-Committee.*

In carrying out these experiments, the great difficulty has been to know when one is dealing with a urine that contains the *M. melitensis.*

A urine collected one day and planted out on Petrie dishes has to be kept four days before the presence or absence of *M. melitensis* can be ascertained. By this time, even if *M. melitensis* be found in the plates, it is no guarantee that it has not died out by the 4th day, and in any case the vitality of any survivors has probably been seriously impaired.

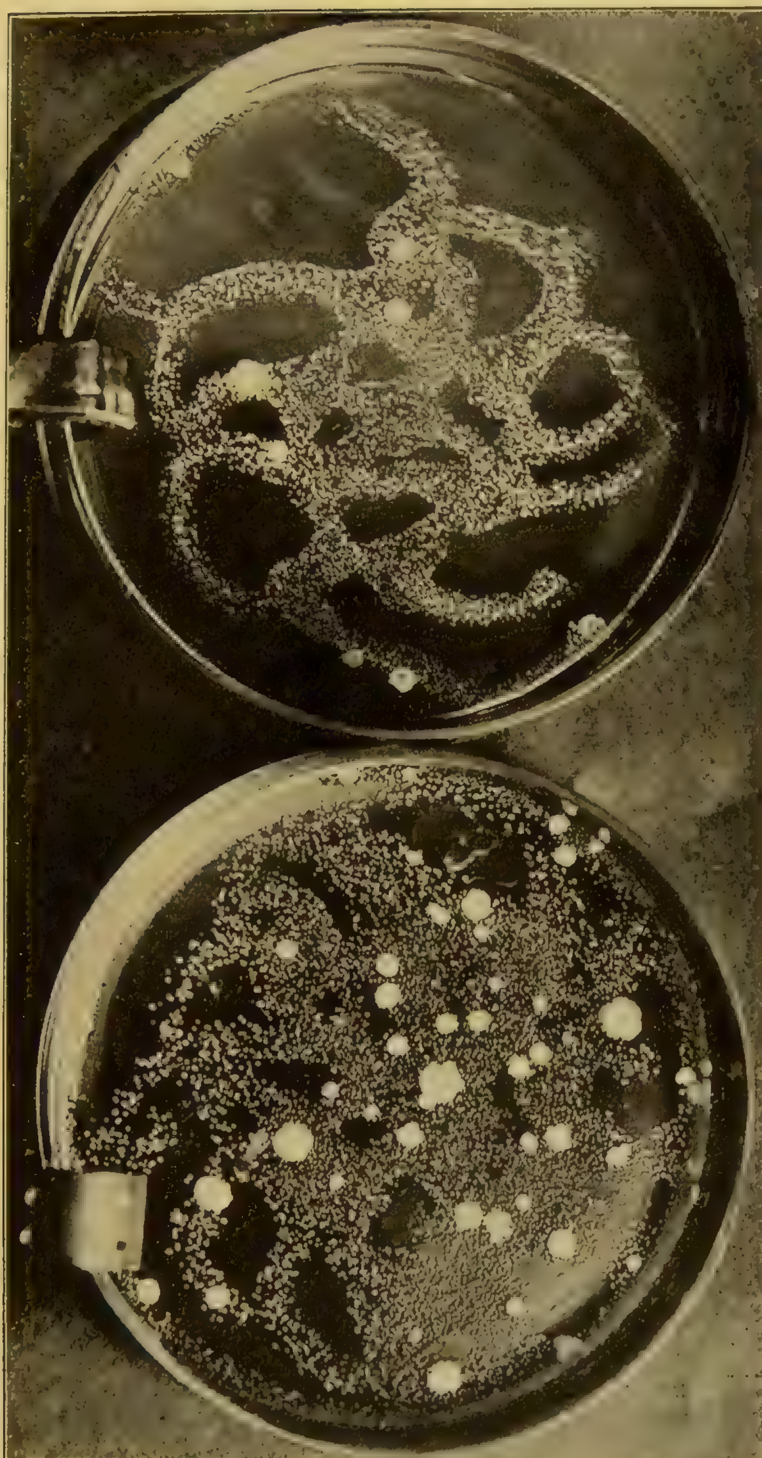
To overcome this difficulty, I looked round for cases that would give a fairly regular supply of infected urine. In this I was fairly fortunate, and then my procedure was as follows:—

A sample of urine was collected every day from these patients, and every day it was—

1. Plated out on nutrose glucose litmus. This served as a control.
2. Allowed to dry on pieces of khaki drill.
3. Mixed with sterile dust.
4. Added to sterile tap water.
5. Added to sterile milk.

On the 3rd and 4th days the control plates were examined, and if *M. melitensis* was present the Experiments (2, 3, 4, 5) were proceeded with. This meant increasing the work greatly, as many samples proved useless.

The majority of samples treated in this way, and proved to be infected, contained *M. melitensis* in very small quantities—*i.e.*, 4 to 30 colonies per cubic centimetre urine. It will be readily understood that the chances of recovering it again after diluting the sample 100 times are very small.



Urine, Surmin, February 1.

1. $\frac{1}{4}$ c.c. plated out on Petrie dish (nutrose glucose-litmus-agar) on February 1, incubated four days.

2. $\frac{1}{4}$ c c. plated out on February 4 and incubated four days.

I.

Experiment 4.

How long does *M. melitensis* in urine, when dried on cloth, retain its vitality ?

A. A series of experiments was first made with urine artificially infected by *M. melitensis.* The method adopted was as follows :—

The cloth used was khaki drill, thoroughly sterilised and cut up into small pieces of ½ inch square. One-quarter of a cubic centimetre of the infected urine was then placed on each piece of cloth, and allowed to dry naturally. At varying intervals a piece was teased out in sterilised water, and the water planted out on a series of Petrie dishes containing the nutrient medium. This was found to be the best way of recovering the *M. melitensis*, as, if the urine-contaminated cloth was first treated in broth, the rapid-growing organisms would render its recovery impossible.

(1) January 8. *M. melitensis* recovered from urine added to Mediterranean Fever urine 24 hours old with acid reaction. Procedure as above, except that the cloths were put in the incubator for six hours at 37° C. to dry the quicker.

Series of plates were made on January 10, 12, 14, and 16 from pieces of the cloth. *M. melitensis* was not recovered on any of these days ; the plates were found to be very acid, and overgrown.

On the 17th another piece was teased out in sterile distilled water, and phenol phthalein added as an indicator. It required two drops of *n*/10 alkaline solution to render the mixture alkaline to the indicator. Two more drops of the alkaline solution were added, and then the mixture plated out on a series of Petrie dishes. The result was that *one colony of* M. melitensis was found in one of the plates. This colony was put through the tests, and proved to be *M. melitensis.* This experiment was repeated with another cloth on January 23, but without success.

Result :—M. melitensis *found living in a very filthy cloth after nine days.*

(2) January 16. An experiment similar to the preceding was started, with this difference that the urine was fresh and it was allowed to dry naturally. A control plate was made from the infected urine, and the cloth examined on January 17, 18, and 23. The result in every case was nil, the plates all being very foul and acid.

(3) January 20. Another urine was artificially infected and the same procedure carried out. A control was made from the urine on the 1st day and *M. melitensis* was easily recovered.

The cloth was examined on the 21st and 25th *and* M. melitensis *was easily recovered* on these days.

In contrast to the other two experiments the plates were very clean and comparatively free from contaminations.

The cloth of the 21st provided *M. melitensis* in great quantities, that of the 25th rather scantily.

On February 1 another cloth was examined. No *M. melitensis* was recovered, the plates were very clean.

On February 3 the cloth gave a few colonies of *M. melitensis*, this was the 14th day of the experiment. I continued examining these cloths every other day but never found *M. melitensis* again; the plates were always very clean, so that there was no chance of its being hidden by other organisms as was the case in the two former experiments.

Result.—M. melitensis *found alive after* 14 *days.*

B. The carrying out of this experiment with a naturally infected urine was very difficult and disheartening; it was only after many failures that I obtained a suitable urine.

This was urine of Surmin, February 1; it was not one of the samples which I had been using in the series of cloth experiments and so had not been put on to cloth on the 1st day. But having found *M. melitensis* in great quantities after the plate had been incubating three days and having fortunately kept the sample, I was able to put it on cloth when it was three days old; at the same time I made a control plate from this urine, and by looking to the report dealing with the vitality of *M. melitensis* in the urine, the photographs of this control plate and the plate of the 1st day will be seen side by side, showing the presence of *M. melitensis* in enormous quantities.

February 4. Urine of Surmin, February 1, put on cloth. Control as above.

February 7. Cloth examined. M. melitensis *recovered* in great quantities.

February 17. Cloth examined. *No* M. melitensis recovered.

February 21. Cloth examined. *One colony of* M. melitensis *recovered.* This colony was of a very dark amber colour. It answered all the tests for *M. melitensis* perfectly. I continued for some days making plates from the cloth but got no further recovery, though everything was favourable, as the plates showed very little growth.

Result.—M. melitensis *excreted in urine dried on cloth will retain its vitality for* 17 *days*, though it tends to die out before the 13th day.

It should be remembered that this sample of urine had stood for three days before being put on cloth, so that the vitality of the *M. melitensis* had probably been impaired.

II.

Experiment 3.

How long does *M. melitensis* retain its vitality in dust moistened with infected urine?

Procedure.—Dust used was the dust and mud from the road, which,

when dry, blows about as a very fine powder. It was thoroughly sterilised in hot air chamber. The infected urine was mixed up with it until it became of a pasty consistency. This was allowed to dry at room temperature and when dry was examined for *M. melitensis.* A small quantity of the dust was mixed up with sterile distilled water, thoroughly shaken, and the fluid pipetted off and planted out on plates. The dust generally was so fine that it would form an emulsion in the water and the whole mixture could be planted out. In this way it was found that *M. melitensis* could very readily be recovered.

A. A series of experiments was first performed with dust and urine which had been artificially infected with *M. melitensis* recovered from urine. The first two of these were unsuccessful owing to the very filthy state of the urine used. The third gave the following result:—

January 20. *M. melitensis* recovered from urine added to Mediterranean Fever urine; resulting emulsion added to dust which was allowed to dry at 16° C.

January 21. Small quantity plated out. M. melitensis *in great quantities* recovered on 3rd day, still more on the 4th.

January 25. Small quantity planted on one plate; same result as on 21st. M. melitensis *recovered.*

February 3. Another plate made. M. melitensis *recovered* in good quantities.

February 9 (20th day). Three plates made. Two *contained* M. melitensis in good quantity; one contained none. All the plates were very clean.

February 17 (28th day). Two plates made. M. melitensis *recovered* from both in great quantity.

February 25 (36 days). Two plates made. *No* M. melitensis was recovered from these plates.

March 1 (41 days). Six plates were made. M. melitensis *was recovered* from only two plates and in very small numbers.

March 4 (44 days). Seven plates made. Two of these *each contained one colony of* M. melitensis. This finished the supply of infected dust.

Result.—It is evident from this that the *M. melitensis retained its vitality* in the dust with no difficulty *for one month,* but after that time it died out quickly, but could be found when large quantities of dust were used and many plates made *up to the 44th day.*

B. Series of experiments were then made with urines naturally infected on the lines laid down in the beginning of this Report, viz., mixing consecutive series of fresh samples of urine with dust and then waiting until the controls were positive or negative for the presence of *M. melitensis.*

(1) In the first series *M. melitensis* was found in five controls, but only in quantities of 1 to 8 colonies per $\frac{1}{4}$ c.c. These dusts were plated out frequently and in large quantities, but no recovery of *M. melitensis* was made.

(2) In the second series 12 controls contained *M. melitensis*, but no *M. melitensis* was recovered from the dust. The number of colonies of *M. melitensis* in the controls of this series varied from 1 to 13 per $\frac{1}{4}$ c.c.

(3) On February 4 it was found that a sample of Surmin's urine passed on February 1 contained *M. melitensis* in large quantities (see Report on Vitality in Urine and Cloth Experiments), and some of it was mixed with dust and allowed to dry at room temperature.

February 5. Dust was dry and some was planted out on three plates. M. melitensis *was recovered* from each of these plates in great quantities, first appearing on the 3rd day.

Judging from the experiment with dust and artificially prepared urine, I allowed this dust to stand undisturbed till February 17 (13th day of experiment). On this day I again planted out some of the dust, but could not recover *M. melitensis.* I again planted it out on February 21, 25, and March 1, but could not recover it again.

Result.—Dust contaminated with naturally infected urine contained great *quantities of* M. melitensis *after* 24 *hours, but after* 13 *days the* M. melitensis *had completely died out.*

Note.—The same remark applies here as in the cloth experiment, viz., that the urine was three days old before being put in dust. Consequently, the vitality of *M. melitensis* may have been considerably impaired.

Experiments with Unsterilised Soil.

A red soil obtained from a garden bed was used. The method adopted was the same as for sterilised dust, but the proportion of sterile water to soil was greater. The urines used were the same as used in the second series of dust experiments. Plates were obtained in which the colonies were fairly discrete, but no *M. melitensis* was recovered.

III.

Experiment 5.

To determine vitality of *M. melitensis* in infected urine when added to sterile tap water. The method of procedure was as indicated above.

Fresh samples of urine were added to the sterile water contained in flasks of 100 c.c., or in test-tubes of 10 c.c.

One c.c. of urine was added to 100 c.c. and $\frac{1}{4}$ c.c. to 10 c.c. Controls were at the same time taken from each sample of urine and if *M. melitensis* was found the experiment was proceeded with.

In this way 20 samples of urine were tried, five in flasks and 15 in test-tubes.

Of those put in flasks three were found to contain *M. melitensis* in small quantities (viz., 72, 8, and 4 colonies per cubic centimetre). These three flasks were plated out on 4th, 7th, 8th, 14th, 15th, 17th, and 25th days. *M. melitensis* was not recovered.

Of those put in test-tubes, two were found to contain *M. melitensis* (4 and 12 per cubic centimetre). These were plated out on the 5th, 8th, 12th, and 15th days. *M. melitensis* was not recovered.

Being so unsuccessful with the experiment conducted with naturally infected urine, I then carried it out with urine artificially infected with *M. melitensis.*

February 14. The urine used was that of a Mediterranean Fever patient, freshly drawn, and the *M. melitensis* used had also been isolated from the urine of a Mediterranean Fever case.

The *M. melitensis* was added to the urine until a milkiness was visible. One c.c. of this emulsion was added to a flask containing 100 c.c. of sterile tap water and the flasks allowed to stand in the laboratory cupboard, where there was practically a constant temperature of 15° C.

On the following days, $\frac{1}{4}$ c.c. of the sediment was plated out on Petries containing nutrose-glucose-litmus-agar, February 15, 16, 17, 18, 19, 21, 23 and every day to March 4, 6, 11, 15. M. melitensis *was recovered up to and on March* 6, *being the* 20*th day of the experiment.*

For the first four days only one plate was taken from the flask, and the result was as follows:—On February 15 (the first completed day) the *M. melitensis* was recovered in great quantity, the first appearance being noticed on the 17th (48 hours' growth); on February 16 only five colonies appeared; on February 17 one only, and on the 18th none. Thereupon three plates were made each day and *M. melitensis* was always recovered from one or two of them.

The plates taken from February 21 to March 11 all contained numbers of colonies which were practically identical with *M. melitensis* to the naked eye by transmitted light, but by reflected light were a dull white and opaque instead of having a greenish blue halo appearance. This organism was a coccus slightly larger than *M. melitensis,* and which tended to remain in chains of four and five when emulsified in salt solution.

This organism gave a great deal of bother, especially towards the end of the experiment, as I found it increasingly difficult to separate the *M. melitensis* from it. When fishing a *M. melitensis* colony from the plate, and feeling certain that nothing else had been touched, I found that the sub-culture was more frequently than not contaminated by this organism, which in the sub-culture on nutrose-glucose-litmus grew with the production of acid. It was generally necessary to sub-culture twice before obtaining a pure growth of *M. melitensis.*

This organism when sub-cultured was an acid producing streptococcus not agglutinated by Mediterranean Fever serum and partly losing its stain when treated by Gram's method.

On March 11 and 15 no *M. melitensis* was recovered and the plates made on the latter date were very dirty, being overgrown with rapid growing alkaline colonies.

Conclusions. That *M. melitensis tends to die out quickly in sterile tap water, but can be recovered from it up to the 20th day.*

Experiment 6.

To determine survival of *M. melitensis* in infected urine which has been added to sterile milk. This experiment was carried out on the same lines as the former. In every case test-tubes containing 10 c.c. of sterile milk, to which a little litmus had been added, were used; the amount of urine added to each test-tube of milk was ¼ c.c.

December 12. Six samples of urine added to six litmus milk tubes. Control: no *M. melitensis* found in any one of the samples.

December 13. Five samples urine added to milk. Control: one sample (Kinsella) contained one colony *M. melitensis* per cubic centimetre. Four ¼ c.c. of the mixture of milk and this infected sample were plated out on four nutrose-glucose-litmus-agar plates on December 18, 24, 27. No *M. melitensis* was recovered.

December 14. Six samples urine added to milk. Control: one sample (Kinsella) contained two colonies *M. melitensis* per cubic centimetre. The infected milk was plated out on December 21, 24, and 27. No *M. melitensis* recovered.

December 19. Three samples urine added to milk. Control: none contained *M. melitensis*.

December 20. Ditto. Five samples of urine.

December 21. One sample urine from Boy Bolt. Control found to contain 56 colonies *M. melitensis* per cubic centimetre. The milk was plated out on the following days: December 27 (6th day of experiment). Milk showed no coagulation and remained alkaline. M. melitensis *recovered.*

December 31 (10th day of experiment). Milk still alkaline, no coagulation. M. melitensis *recovered.*

January 4 (14th day)
January 8 (18th day) } Milk alkaline, *M. melitensis* not recovered.

January 12 (22nd day). Milk turned acid, *M. melitensis* not recovered.

December 24. Five samples of urine added to milk. Control: Bolt found to contain 16, and Gane 20 colonies *M. melitensis* per cubic centimetre. Bolt had turned the milk acid on the 31st. *M. melitensis* not recovered. Gane remained alkaline till January 4, *M. melitensis* not recovered.

December 24. Four samples urine added to milk. Control: one sample (Gane) was found to contain 280 colonies *M. melitensis* per cubic centimetre. The milk was plated out on the following days:

December 31 (4th day)
January 4 (8th „)
„ 8 (12th „)
„ 12 (16th „)
} Milk remained alkaline all this time. M. melitensis *was recovered on each of these days.*

January 16 (20th day)
„ 20 (24th „)
„ 24 (28th „)
} By the 20th day (January 16) milk had turned acid. No *M. melitensis* was recovered after this.

After having recovered the *M. melitensis* up to the 16th day, it was decided to carry on the experiment without touching the infected milk till the 17th day of the experiment.

January 21. One sample of urine added to milk. Control gave no *M. melitensis.*

January 22. One sample of urine, ditto.

January 24. One sample urine added to milk. Control contained eight colonies *M. melitensis* per cubic centimetre. Milk plated on following days:—

February 10 (17th day of experiment)
„ 14 (21st „ „)
} Milk remained alkaline. *M. melitensis* not recovered.

„ 18 (25th „ „). Milk turned acid. *M. melitensis* not recovered.

January 25. One sample of urine added to milk. Control contains four colonies per cubic centimetre. Plated out February 12 and 18. *M. melitensis* not recovered.

January 27. Same as January 25. Plated out on February 14, *M. melitensis* not recovered.

January 29. One sample urine. Control contained no *M. melitensis.*

January 30. Same as January 25. Plated out February 16 and 22. No *M. melitensis* recovered.

Six more samples were added to milk in the same way on February 4, 5, 6, and 7, but the controls were negative.

The *M. melitensis* recovered above was proved by the usual tests.

The only thing to be noted as regards cultural or other appearance is that in plates of the 12th and 16th days the colonies were of a darker amber colour than usual.

Summary.

Forty-eight samples of urine were added to milk; control experiments proved the presence of *M. melitensis* in 10 of them. M. melitensis *was recovered* from two of these; in one up to the 10th day and in the other *up to the 16th day.* In both cases the milk remained alkaline as long as the *M. melitensis* was recovered.

These urines must have been very clean and comparatively free from acid organisms. In most cases the milk became curdled in four days' time.

Conclusions.—M. melitensis will live in sterile milk which has been contaminated by infected urine as long as the milk remains alkaline or neutral to litmus.

Summary.

M. melitensis in the condition in which it is excreted in urine will retain its vitality—

1. Dried on cloth for 17 days.
2. In dust: for less than 13 days.
3. In sterile tap water. Not recovered.
4. In sterile milk for 16 days.

M. melitensis derived from urine, grown on media and then added to Mediterranean Fever urine, retains its vitality—

1. Dried on cloth for 14 days.
2. Dried in dust for 44 days.
3. Mixed with sterile tap water for 20 days.

VI. A PRELIMINARY NOTE ON THE EXAMINATION OF THE BLOOD OF GOATS SUFFERING FROM MEDITERRANEAN FEVER.

By Dr. T. ZAMMIT, Member of the Mediterranean Fever Commission.

On June 14, as detailed by Major Horrocks, I examined the blood of six goats, which were brought to the lazaretto on June 12, and obtained the following results :—

Goat No. 1.—Strong immediate reaction, in dilution of 1 to 20.
Goat No. 2.—Strong immediate reaction, in dilution of 1 to 20.
Goat No. 3.—Strong reaction, after half-an-hour.
Goat No. 4.—No reaction.
Goat No. 5.—Strong reaction, after half-an-hour.
Goat No. 6.—Strong immediate reaction.

On June 15 the bloods were again examined, with identical results.

On June 18 about 5 c.c. of blood were taken from Goat No. 6, and distributed in six broth-tubes. On June 25 passages from the broth-tubes were made on to agar slopes, and the *M. melitensis* recovered in pure culture. This micro-organism was also recovered from the blood of Goat No. 5.

Blood has also been taken from Goats Nos. 1, 2, and 3, and distributed in broth-tubes as usual, but, so far, the *M. melitensis* has not been recovered.

Material from Abattoir.—Dr. Caruana Scicluna having suggested that possibly infected goats might be met with in the abattoir, I have examined 46 spleens removed with aseptic precautions, but, so far, have only recovered the *M. melitensis* from one. The blood from the goats was examined for agglutination with the *M. melitensis*, and a definite reaction was obtained in seven.

(For further details, see 'Proceedings of the Royal Society,' Series B, vol. 76, 1905, No. B 510.)

VII. PRELIMINARY NOTE ON GOATS AS A MEANS OF PROPAGATION OF MEDITERRANEAN FEVER.

By Major W. H. Horrocks, R.A.M.C., Member of the Mediterranean Fever Commission.

(Reprinted from the 'Proceedings of the Royal Society,' Series B, vol. 76, 1905, No. B 510.)

With the object of ascertaining, by experimental inoculation, whether goats could be infected by the *M. melitensis*, six goats were bought on June 12, 1905, from two different herds, and placed in the lazaretto. On June 14 Dr. Zammit, as a preliminary step to our experimental work, took blood from each of these goats, and proceeded to test the action of the serum on the *M. melitensis*. He found, to his great surprise, that the serum of five of the goats, when considerably diluted, caused agglutination of this microbe. On June 15 similar results being again obtained, Dr. Zammit brought specimens of the bloods to the Public Health Laboratory, and asked me to confirm his observations. I obtained the following results:—

Goat No. 1.—Blood serum diluted 1 to 10 and 1 to 40 caused immediate agglutination of the *M. melitensis*, visible to the naked eye. When diluted 1 to 100, however, the serum gave no reaction.

Goat No. 2.—Blood serum diluted 1 to 10 and 1 to 40 caused immediate agglutination of the *M. melitensis*. A dilution of 1 to 100 produced a complete reaction after 15 minutes.

Goat No. 3.—Blood serum diluted 1 to 10, 1 to 40, and 1 to 100, caused immediate agglutination of the *M. melitensis*, but, in the case of the dilution 1 to 100, the clumps were not visible to the naked eye until after 15 minutes.

Goat No. 4.—The blood serum produced no reaction with the *M. melitensis*.

Goat No. 5.—The blood serum diluted 1 to 10 caused immediate agglutination, but dilutions of 1 to 40 and 1 to 100 did not produce a complete reaction until after 15 minutes.

Goat No. 6.—Blood serum diluted 1 to 300 caused complete agglutination of the *M. melitensis*, visible at once with the naked eye.

The reactions thus obtained, and especially that of Goat No. 6, suggested that possibly five of the goats were suffering from Mediterranean Fever, acquired under natural conditions. The goats were stated to be healthy, but were sold cheaply, as they had given very little milk for some time. They were bought from pens in the neighbourhood of Birchircara and St. Julians, and taken straight to the lazaretto, where they were placed in clean stalls, which had never been used for any experimental work with the *M. melitensis.*

Dr. Zammit and I then arranged to make a complete study of these animals; Dr. Zammit undertook the investigation of the blood, and I made myself responsible for the bacteriological examination of the milk and urine.

Bacteriological Examination of Milk and Urine obtained from Naturally Infected Goats.

Goat No. 6.—I commenced work with this goat, as its blood serum, when diluted 1 to 300, caused immediate agglutination of the *M. melitensis.* The animal did not appear well, and had a very poor coat. The udders were flaccid, but the milk exuded appeared normal in character. The temperature was taken morning and evening, and compared with that of a healthy goat. The evening temperature never rose above 103°, and, as this temperature is often recorded in the case of perfectly normal goats, a febrile temperature could not be said to be present. On June 18 milk was withdrawn, and 1 c.c. centrifugalised; the deposit was then carefully spread over 10 litmus-nutrose-agar plates. After four days' incubation at 37° C., colonies of the *M. melitensis* appeared in every plate. The colonies were at once tested with a dilute (1 to 100) specific serum obtained from an inoculated rabbit. The micrococci were found to agglutinate at once, the clumps being visible to the naked eye. Some of the colonies were then planted out on agar slopes, and the resulting growths, when subjected to the usual confirmatory tests, showed that the *M. melitensis* was undoubtedly being excreted in the milk of this goat.

On June 22 the milk was again examined and the *M. melitensis* recovered once more.

On June 23 examination of the urine was commenced. The vagina was washed out with an antiseptic solution and a catheter, previously sterilised in boiling water, passed into the bladder. The urine so obtained was plated on litmus-nutrose-agar, but after four days' incubation at 37° C., in spite of the precautions taken, the plates were found densely crowded with saprophytic organisms, and the *M. melitensis* could not be detected.

On June 24 and 26 the urine was again plated, the same precautions being used, but the plates were densely crowded with foreign organisms and the *M. melitensis* could not be seen.

On June 27, 28, 29, and 30, and on July 1, 3, 4, 5, 7, 8, 9, and 10, the urine was also examined, but up to the present the *M. melitensis* has not been recovered.

The milk was plated again in June and July, and the *M. melitensis* was found on each occasion.

Result.—The *M. melitensis* appears to be steadily excreted in the apparently normal milk of this goat, but up to the present it has not been found in the urine.

Goat No. 1.—This animal appeared healthy, but the udders were flaccid, and the milk exuded had a thin serous appearance. The temperature was taken regularly, but no indications of fever were observed.

On June 22, 1 c.c. of the milk was centrifugalised and the deposit plated. After four days' incubation at 37° C., the plates were found so densely crowded with colonies of the *M. melitensis* that an accurate count could not be made.

On June 24 and 26 the milk was again examined and similar results were obtained.

On June 26, 29, and 30 the urine was examined, but no signs of the *M. melitensis* could be discovered.

On July 1, 10 c.c. of the urine were centrifugalised and the deposit plated; four days later every plate was found studded with colonies of the specific microbe. The colonies were fished, planted on agar slopes, and the resulting growths tested in the usual manner.

Result.—The *M. melitensis* is excreted in very large numbers in the serous-looking milk of this goat. It is also excreted in the urine.

Goat No. 2.—This goat appeared quite well, and the milk exuded from the udders had a normal appearance. There were no indications of fever.

On June 22, 1 c.c. was centrifugalised and the deposit plated. After four days' incubation about 30 colonies appeared in every plate. On June 24 and 26 the milk was again examined, and colonies of the *M. melitensis* were recovered on both occasions.

The urine was examined on June 23, 26, 27, 28, 29, and 30, and on July 1, 3, and 6, but the *M. melitensis* could not be detected.

Result.—The *M. melitensis* appears to be excreted in small quantity in the normal-looking milk of this goat. It has not yet been detected in the urine.

Goat No. 3.—This goat looked healthy and had no fever, but its milk was thin and serous. On June 22 the milk was examined, one loopful of the serous milk being spread over each plate. After four days' incubation all the plates were found so densely crowded with colonies of the *M. melitensis* that an accurate count could not be made.

On June 24 and 26 the milk was again examined and similar results were again obtained.

The urine was examined on June 23, 26, 28, and 30, and on July 1, 3, 6, 8, 9, 10, 11, but no signs of the *M. melitensis* could be discovered.

Result.—The *M. melitensis* appears to be present in enormous quantities in the thin serous-looking milk of this goat, but it has not yet been found in the urine.

Goat No. 5.—This goat was in poor condition, the udders were flaccid, and the milk exuded had a thick jelly-like appearance.

On June 22 the milk was examined, one loopful of the jelly-like material being spread over each plate. After four days incubation all the plates were covered with minute colonies of the *M. melitensis.* On June 24 and 26 the milk was again examined, and densely crowded plates were obtained as before.

On June 25 and 30 the urine was examined, but no colonies of the *M. melitensis* were detected.

On July 1 the urine was again plated, and four days later every plate was found to contain numerous transparent colonies strongly resembling those of the *M. melitensis.* Some of the colonies were fished and planted out on agar slopes. The resulting growths were then subjected to the usual confirmatory tests, and the *M. melitensis* proved to be undoubtedly present.

The five goats just examined being considered by their owners to be "out of milk," would not be likely to be employed for milking purposes, though in the case of Goats Nos. 2 and 6, the milk might easily have been used without any fear of suspicion arising as to its being abnormal. Consequently it appeared very desirable to examine the herds which were actually supplying milk to Valetta, Sliema, and the various hospitals.

I therefore asked Captain Kennedy, R.A.M.C., to visit the various herds, and, with the owners' consent, take blood from the ears, and test the action of the sera on the *M. melitensis.* The results he obtained are given in Part VIII; it will be seen that, out of 161 goats examined, 84 gave a reaction, corresponding to a percentage of 52 probably infected with Mediterranean Fever. I then obtained samples of milk from some of the apparently infected animals, and proceeded to plate them on litmus-nutrose-agar. The following results have been obtained up to the present time:—

Examination of the Goats supplying Milk to Forrest Hospital.

I visited this herd, which assembles outside the hospital gate every morning, and selected Goats Nos. 38, 48, 37, and 43 from Captain Kennedy's list.

Goat No. 38.—The milk from this animal was centrifugalised, and the deposit plated on July 4, 5, 6, 7, 8, and 10, but, up to the present, the *M. melitensis* has not been isolated.

Goat No. 48.—The milk was examined on the same dates as Goat No. 38, but, so far, the *M. melitensis* has not been isolated.

Goat No. 37.—The milk of this animal was taken on July 4, and 2 c.c. centrifugalised; the deposit was then plated. After four days' incubation every plate was found densely crowded with small colonies of the *M. melitensis;* the colonies were so numerous that it was impossible to make an accurate count. The colonies were fished and planted on agar, the growths resulting responded to all the tests characteristic of the *M. melitensis.*

On July 5 and 6 the milk was again plated, and similar results were obtained.

As this goat was in full milk, there cannot be any doubt that the *M. melitensis* was being excreted in large numbers. A pint of the milk was then collected, and Dr. Zammit very kindly made a chemical examination of the sample. The result given below shows that the milk was of good quality.

Analysis of Milk from Goat No. 37.

Density at 15° C.	1030
Fat	4·3 per cent.
Total solids	13·18 ,,
Solids, non-fat	8·8 ,,
Ash	0·51 ,,

Goat No. 43.—The milk of this goat was examined on July 4, 5, 6, 7, 8, 9, and 10, but, up to the present, the *M. melitensis* has not been isolated.

A reference to Captain Kennedy's list shows that, while Goat No. 37 reacted in a dilution of 1 to 60, Goats Nos. 38, 48, and 43 only reacted in a dilution of 1 to 20, and were probably in an early stage of the disease.

Examination of a Small Herd supplying Milk to Valetta Station Hospital.

Goats Nos. 27, 30, and 32 were selected from this herd. The goats were kept at Casal Curmi, and brought every morning to the Station Hospital.

Goat No. 30.—On June 29 and 30 milk was centrifugalised and plated in the usual manner, but the *M. melitensis* was not detected.

On July 1 plates were again made, and a few typical colonies appeared.

On July 3 10 c.c. of the milk were centrifugalised, and the deposit plated; four days later every plate was found densely crowded with colonies of the *M. melitensis.*

On July 6 similar results were obtained.

A sample of the milk was then analysed by Dr. Zammit, and found to have an average chemical composition.

Goats Nos. 27 *and* 32.—The milk from these goats was examined on June 29 and 30, and on July 1, 3, 7, 8, and 10, but, up to the present, the *M. melitensis* has not been isolated.

Examination of a Small Herd Supplying Milk to Valetta.

This herd assembled in St. John's ditch, and 17 out of 25 animals showed a blood reaction with the *M. melitensis*, and six of them reacted when the serum was diluted 1 to 100. Goats Nos. 50 and 52 were selected from Captain Kennedy's list.

Goat No. 50.—On July 6, 1 c.c. of the milk was centrifugalised and the deposit spread over the usual plates. Four days later all the plates were found densely crowded with small colonies of *M. melitensis*. The confirmatory tests were applied in the usual manner. This animal was considered one of the best milkers in the herd, and its owner valued it at £5, whereas the ordinary price for a goat in milk varies from £3 to £4.

Goat No. 52.—This animal appeared in good health and its udders were full of milk. It was purchased and placed in the lazaretto.

On July 5 milk was withdrawn and 1 c.c. centrifugalised; the deposit was then spread over nutrose-agar plates in the usual manner. After four days' incubation at 37° C., all the plates were found so crowded with colonies of *M. melitensis* that a reliable count could not be made.

On July 6 and 8 the milk was again examined and similar results were obtained.

A sample of the milk was submitted to Dr. Zammit for chemical analysis; he obtained the following results:—

Specific gravity at 15° C........................... 1031
Total solids, 14·0 per cent.; fat, 3·6 per cent.; ash, 0·73 per cent.

Examination of a Herd Supplying Milk to Sliema.

Two goats were bought from this herd and placed in the lazaretto. The pens were in the neighbourhood of Misida.

Goat No. 15.—On July 5 the blood was examined and the serum, diluted 1 to 50, was found to cause complete agglutination of the *M. melitensis* visible to the naked eye. The goat appeared to be in good health, and the udders were full of milk. Some milk was withdrawn and 2 c.c. centrifugalised; the deposit was then plated in the usual manner. On July 9 the plates were found covered with small colonies of the *M. melitensis*.

On July 6 the milk was again examined, and the deposit from

1 c.c. produced as before an immense number of colonies of *M. melitensis.*

The urine was withdrawn by a catheter and plated on July 5, 6, 7, 8, 9, and 10, but up to the present the *M. melitensis* has not been isolated.

A chemical analysis of the milk was made by Dr. Micalef, with the following results :—

Total solids, 13·5 per cent. ; fat, 4·1 per cent. ; ash, 0·75 per cent.

Goat No. 16.—This goat was taken from the same herd as No. 15. On July 4 the blood was examined, and the serum diluted 1 to 60, was found to cause immediate clumping of the *M. melitensis.* The milk and urine have been examined daily since July 4, but up to the present the *M. melitensis* has not been isolated from either source.

Conclusions.—The results obtained show that some of the goats in every herd examined are suffering from Mediterranean Fever. The *M. melitensis* is exuded in the milk in enormous numbers when the disease has been present sufficiently long to cause a change in the physical characters of the fluid. It is also excreted in considerable numbers even when the animals are in "full milk," and no changes have occurred in either the physical or chemical characters of the milk.

The *M. melitensis* is also excreted in the urine of goats suffering from Mediterranean Fever, but up to the present it has only been found when the disease has existed for some time and physical changes have occurred in the milk.

VIII. EXAMINATION OF GOATS' BLOOD FOR REACTION TO MEDITERRANEAN FEVER.

By J. Crawford Kennedy, R.A.M.C., Member of the Mediterranean Fever Commission, Malta.

No. of herd.	Owner and number in each herd.	Address.	Milk supplied to—	Total number examined.	Number that gave no reaction.	Number that reacted to Med. Fever.	Per-centage of reactions.	Table showing amount of reaction in each infected goat by dilutions up to $\frac{1}{100}$. Dilution.	10.	20.	40.	60.	80.	100.
1	C—, Nos 1 to 4 and 74 to 83	Casal Tarshiel near Casal Paulo	Cottonera Hospital, Zabbar Gate and near lying part of town	14	7	7	50	No. of goat	2 80	74 78	1 75	... ...	... ...	83 ...
								Total ...	2	2	2	...	...	1
2	A— M— and F— G—, Nos. 5 to 17	Zabbar ...	Cottonera Hospital, Zabbar Gate and near lying town	13	12	1	7·6	No. of goat	...	...	...	...	...	5
								Total ...	...	...	...	...	...	1
3	J—, Nos. 18 to 20	Hamrun ...	Valetta	3	3	...	...	...	...	...	...	...	...	...
4	J— F—, Nos. 21 to 23	Casal Curmi	Valetta Hospital and town	13	9	4	30·7	No. of goat	... ...	32 30	... ...	32 ...	... ...	27 ...
								Total ...	...	2	...	1	...	1

No. of herd	Owner and number in each herd.	Address.	Milk supplied to—	Total number examined.	Number that gave no reaction.	Number that reacted to Med. Fever.	Percentage of reactions.	Table showing amount of reaction in each infected goat by dilutions up to $\frac{1}{100}$. Dilution.	10.	20.	40	60.	80.	100.
5	C—, Nos. 34 to 48	St. George's	Forrest Hospital ...	15	10	5	33·3	No. of goat	...	38	...	37	...	...
									...	39	...	...	...	...
									...	43	...	...	...	...
									...	48	...	...	...	...
								Total ...	...	4	...	1	...	...
6	M— M—, Nos. 49 to 73	St. John's Ditch	Valetta	25	8	17	68	No. of goat	51	54	...	64	...	50
									59	66	...	...	...	52
									62	67	...	...	...	55
									63	70	...	...	...	60
									65	...	...	...	...	68
									73	...	...	...	...	71
								Total ...	6	4	...	1	...	6
7	G— M—, Nos. 84 to 129	Hamrun ...	Valetta	46	20	26	56	No. of goat	97	88	85	103	...	99
									109	93	90	111	...	102
									117	96	...	119	...	105
									120	106	...	126	...	121
									123	110	...	...	...	122
									...	112	...	...	...	129
									...	113	...	...	...	...
									...	128	...	...	...	...
									...	128	...	...	...	...
								Total ...	5	9	2	4	...	6

8	F— M—, Nos. 130 to 161	Pietá ...	Valetta	32	8	24	75	No. of goat	137	134	131	147	...	132
									140	135	157	...	...	133
									144	141	...	...	...	136
									148	149	...	...	...	138
									...	...	...	...	...	145
									...	...	...	...	...	151
									...	...	...	...	...	153
									...	...	...	...	...	154
									...	...	...	...	...	155
									...	...	...	...	...	156
									...	...	...	...	...	159
									...	...	...	...	...	160
									...	...	...	...	...	161
								Total ...	4	4	2	1	...	13
			Total	161	77	84	52·17							

Examination of a Herd of Goats kept Privately and not allowed outside their own Field, as a Comparison with the Herds that Walk into Town Daily.

Total examined	10
No reaction	5
React to Mediterranean Fever	5

Of the five which reacted:—

1 reacted in dilution	$\frac{1}{10}$
3 " "	$\frac{1}{20}$
1 " "	$\frac{1}{100}$

∴ The percentage of infected goats in this herd is 50 per cent., comparing very closely with 52 per cent. of the public herds.

IX. RESULTS OF EXAMINATIONS FOR THE ISOLATION OF *MICROCOCCUS MELITENSIS* FROM THE BLOOD, URINE, AND SPUTUM OF CASES INFECTED WITH MEDITERRANEAN FEVER IN HASLAR HOSPITAL.

By P. W. BASSETT-SMITH, Fleet-Surgeon, Haslar.

Blood.—The blood was obtained from the median basilic vein of the arm, which had been carefully sterilised; from 1 to 3 c.c. were taken with an all-glass anti-toxin syringe; the blood was at once injected into flasks containing 50 c.c. of peptone broth; from this sub-cultures were made on to agar daily for 14 days at least, the resulting growth being tested by—

(1) Agglutination with specific serum.
(2) Alkaline reaction with litmus milk.
(3) Negative staining by Gram.

In all 27 bloods were examined from 24 patients, with 16 positive and 11 negative results, as shown in the following table :—

No.	Day of disease.	Condition.	Temperature.	Amount of blood taken.	Result.
			° F.	c.c.	
1	50	Acute relapse	102·4	3	Positive
2	142	Slight ,, ...	99·4	2·5	,,
3	84	Acute ,, ...	102	3	,,
4	117	,, ,, ...	103·4	3	,,
5	92	,, ,, ...	102	3	,,
6	23	Prim. wave	104	3	,,
7	34	Sec. ,, ...	103	3	,,
8	167	Relapse..........................	102	1	Negative
			short relapse with neuritis		
9	143	Acute relapse	101	2	Positive
10	44	,, ,, ...	101·2	2·5	,,
11	105	,, ,, ...	102·6	3	,,
12	153	,, ,, ...	105	2	,,
13	44	,, ,, ...	102·8	0·5	,,
14	41	,, ,, ...	102	2	,,
15	80	,, ,, ...	102·6	2	,,
16	111	,, ,, ...	101	2	,,
17	61	,, ,, ...	103	2	,,
18	122	Convalescent	N.	1	Negative
19	185	Cachexia..........................	N.	2	,,
20	110	Slight relapse	100	3	,,
			slight wave, not repeated		

No.	Day of disease.	Condition.	Temperature.	Amount of blood taken.	Result.
			° F.	c.c.	
21	165	Convalescent	N.	3	Negative
			went out next day		
22	159	„	N.	3	Negative
			no return of the fever		
23	130	„	N.	3	Negative
24	78	„	N.	3	„
			no return of the fever		
25	134	„	N.	3	Negative
			no fever, great anæmia		
26	120	„	99	3	Negative
			flask contaminated on the 14th day		
27	1 year	Cachexia	N.	3	Negative

Two flasks after being inoculated were found to be contaminated and are not included in this list, the others were either sterile or contained a pure culture of *M. melitensis.*

Excepting for cases 8, 20, and 26, the *M. melitensis* was recovered from all cases examined where fever was present. When not found I think the prognosis is favourable for continued convalescence.

Urines.—The technique as recommended by Major Horrocks was followed—the penis being washed with carbolic acid solution, the urine collected in a sterile test-tube after a part had been passed to clear the urethra, and then 0·2 c.c. plated on litmus-glucose-nutrose-agar, incubated at 37° C.

In all 46 urines have been thus examined, of 18 patients, with the following results. In the great majority of the plates, in 24 hours the surface was covered by a spreading foul-smelling acid organism, or was thickly studded with opaque rapidly growing colonies of a rather large coccus, but in two instances typical colonies of *M. melitensis* were present as a pure culture, both being from the same patient.

No. of case.	No. of examinations.	Condition.	Result.
1	1	Acute relapse	Negative
2	7	,, ,, ...	,,
3	1	,, ,, T. 103	,,
4	1	,, ,, ...	,,
5	2	,, ,, ...	,,
6	5	,, ,, ...	,,
7	3	,, ,, ...	,,
8	1	Convalescent	,,
9	7	,, ...	,,
10	2	Acute relapse	,,
11	2	,, ,, ...	,,
12	2	,, ,, ...	,,
13	1	,, ,, ...	,,
14	1	,, ,, ...	,,
15	4	,, ,, ...	,,
16	2	,, ,, ...	,,
17	11	,, ,, ...	1 with 16 col. on plate 1 with 14 col. on plate, pure culture of *M. melitensis* 9 rapidly overgrown
18	1	,, ,, ...	Negative

Unless the urine is free from other organisms, there seemed to be little chance of isolating the *M. melitensis*, the growth of this organism being so much slower than most of the others present.

Case 16 was very acute, in a typhoid condition, and the urine was drawn off with a catheter, but was full of other organisms.

Sputum.—As several of the cases recently received into Haslar were suffering from bronchial catarrh, with expectoration of mucoid sputum, I thought it possible that in these one might be able to isolate the organism from the sputum.

Technique.—The sputum in the early morning was received into a sterile test-tube, a fragment of the thickest portion was then fished out on a platinum loop, thoroughly washed in a tube of sterilised water, and again removed to a second test-tube of sterile water, thoroughly mixed, and 0·2 c.c. plated out on nutrose-glucose-litmus-agar, incubated at 37°.

So far no colonies resembling the *M. melitensis* have been met with, and as all the cases have ceased to expectorate, the experiment has ceased.

No. of case.	No. of experiment.	Condition.	Character of sputum.	Result.
1	1	Acute relapse	Muco. purt.	Negative
	2	,, ,, ...	,, ...	,,
2	3	Convalescent	Mucoid	,,
3	4	Acute relapse	,, ...	,,
4	5	,, ,, ...	,, ...	,,
	6	,, ,, ...	,, ...	,,
5	7	,, ,, ...	,, ...	,,
	8	,, ,, ...	,, ...	,,
	9	,, ,, ...	,, ...	,,
6	10	,, ,, T. 104......	,, ...	,,

REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART IV.

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CONTENTS.

I. FURTHER NOTES ON THE ISOLATION OF THE *MICROCOCCUS MELITENSIS* FROM PERIPHERAL BLOOD; AND EXPERIMENTS ON THE DURATION OF LIFE OF THIS MICROBE IN EARTH AND IN WATER.

By Staff-Surgeon R. T. Gilmour, R.N.

(Received August 28, 1905.)

The method of procedure employed was similar to that described in my previous paper.* The cases selected for this series of experiments had well-marked symptoms of Mediterranean Fever, and in no case was the agglutination reaction less than 1 in 50. Control experiments were made to ascertain whether the microbe was present in relatively large quantities of blood. From 1 to 3 c.c. of blood and 30 to 50 c.c. of broth were used for this purpose.

Cases XX and XXXIV are interesting. In the former the *Micrococcus melitensis* was isolated during a relapse on or about the 300th day from the date of the patient first going sick. The latter is a case of Mediterranean Fever occurring during convalescence from enteric.

Case XX, D. J., Lieutenant, R.N.—This officer was admitted into hospital in December, 1903, for Mediterranean Fever. The symptoms were well marked, with an agglutination reaction of 1 in 200. He was discharged to duty in January, 1904. In April, 1904, he forwarded me his serum, and as it only reacted 1 in 10, I gave him a favourable prognosis. At the end of September, 1904, he got very wet whilst out shooting in the Greek Islands, and went sick about 14 days afterwards with fever. On admission into hospital on October 15, 1904, he had well-marked Mediterranean Fever, with an agglutination reaction 1 in 100; later, 1 in 400. On November 4, 1904, about the 300th day since date of first going sick, a pure growth of *Micrococcus melitensis* was recovered from his blood.

Case XXXIV, J. C.—This man was received into hospital with well-marked symptoms of enteric fever: dry, brown tongue, diarrhœa, intestinal hæmorrhage, and an agglutination reaction of 1 in 400 to the *B. typhosus* and negative to *Micrococcus melitensis*. On November 6, 1904, the 7th day of disease, 3 c.c. of blood were extracted from the right median basilic vein and disposed of as follows:—1 c.c. was passed

* Reports of the Commission, Part I, p. 73.

into 19 c.c. of broth (A), 1 c.c. into 9 c.c. (B), and 2 c.c. into 50 c.c. (C). From (A), broth tubes were inoculated with various quantities of emulsion, containing from 0·0025 to 0·05 c.c. of blood. From (B), plate cultures were inoculated with 1 c.c. of emulsion (0·1 c.c. of blood). These tubes and plates remained sterile. Flask (C) showed turbidity after 24 hours, and by the 2nd day contained a profuse growth of the typhoid bacillus. The fever ran an ordinary course, but when the temperature had remained normal for 15 days it again rose, and patient's serum was now found to react both to *Micrococcus melitensis* and *B. typhosus* 1 in 50. On January 20, 1905, the 82nd day of the enteric attack, blood cultivation gave a pure growth of the *Micrococcus melitensis.*

In an experience of two years and a half with Malta Fever I have never found enteric and Mediterranean Fever running concurrently, but I have come across several cases of the latter immediately following the former.

Deductions to be drawn from these experiments :—

(1) That *Micrococcus melitensis* is found in the peripheral blood of about 82 per cent. of cases of Mediterranean Fever. In the 45 cases examined, no control was made in 8, and in 1 the cultures were contaminated. Of the remaining 36 the microbe was isolated in 29, and also in 1 with no control.

(2) That the number of *Micrococcus melitensis* per cubic centimetre of blood is small, rarely reaching 100. Out of the 30 cases quoted above, in only 6 did they number 100 or more. Largest number found, 400 per cubic centimetre.

(3) That the *Micrococcus melitensis* can be recovered as early as the 2nd day and as late as the 300th day of the disease.

(4) That patients convalescent from enteric may contract Mediterranean Fever, so that the former disease does not appear to confer immunity against the latter.

The experiments (p. 5) were undertaken at the suggestion of the Committee of the Mediterranean Fever Commission. The results obtained were similar to those of Horrocks' and Bassett-Smith, with the exception of the life of *Micrococcus melitensis* in sea-water. In sterile sea-water it appeared to me to exist only for a very short time—about 13 days; in non-sterile sea-water the plates were so crowded out with other bacteria that I failed to isolate it after the 1st day.

The following deductions can be drawn from these experiments :—

1. That the *Micrococcus melitensis* can exist for considerable periods outside the body, but that it does not multiply.
2. That it can exist in dry, sterile garden soil for at least 60 days.
3. In sterile tap-water for at least 42 days.
4. In sterile sea-water for at least 13 days.
5. In non-sterile tap-water for at least 7 days.

Experiment.	Day of disease.	Approximate number of *Micrococcus melitensis* per c.c. of blood.
XIV	6	0·0
XV	189	0·0
XVI	16	40·0
XVII	18	Present in control
XVIII	32	0·0
XIX	40	0·0
XX	300	Present in control
XXI	7	0·0
XXII	2	Present in control
XXIII	9	0·0
XXIV	29	Present in control
XXV	8	20·0
XXVI	3	Present in control
XXVII	12	,, ,,
XXVIII	49	,, ,,
XXIX	34	,, ,,
XXX	30	,, ,,
XXXI	10	400·0
XXXII	40	Present in control
XXXIII	45	,, ,,
XXXIV	?	,, ,,
XXXV	7	0·0
XXXVI	12	50·0
XXXVII	5	0·0
XXXVIII	180	0·0
XXXIX	40	333·3
XL	4	0·0
XLI	11	100·0
XLII	17	0·0
XLIII	15	100·0
XLIV	6	Present in control
XLV	12	,, ,,

A. *Duration of Life of* Micrococcus melitensis *in Dry, Sterile Garden Soil.*

Experiment 1.—February 15, 1905. The soil was inoculated with 1 c.c. of an eight-day-old broth sub-culture. The flask was then placed in a dark cupboard, and shaken frequently, the soil being allowed to dry naturally.

Micrococcus melitensis was recovered on the 60th day.

B. *Duration of Life of* Micrococcus melitensis *in Non-sterile Tap-water.*

Experiment 1.—February 2, 1905. One hundred cubic centimetres of tap-water were inoculated with the whole of an eight-day-old agar slope culture.

Micrococcus melitensis was isolated on the 7th day.

C. *Duration of Life of* Micrococcus melitensis *in Sterile Tap-water.*

Experiment 1.—February 3, 1905. Fifty cubic centimetres of tap-water were sterilised by heating to 120° C. in an autoclave for 30 minutes, and were then inoculated with the whole of an eight-day-old agar slope. The flask was kept in a dark cupboard.

The *Micrococcus melitensis* was recovered up to the 6th day.

Experiment 2.—This experiment was repeated with a four-day-old sub-culture.

Micrococcus melitensis was recovered up to the 42nd day.

Experiment 3.—February 8, 1905. Ten cubic centimetres of tap-water, sterilised in the autoclave at 115° C. for twenty minutes, were inoculated with the whole of a five-day-old agar sub-culture.

Micrococcus melitensis was recovered on the 19th day, but not later.

Experiment 4.—This experiment was again repeated. The agar sub-culture used was 12 days old.

Micrococcus melitensis was recovered on the 23rd day.

D. *Duration of Life of* Micrococcus melitensis *in Non-sterilised Tank-water.*

Experiment 1.—February 15, 1905. The water was obtained from a foul drinking tank, contaminated with large quantities of animal and vegetable matter.

The *Micrococcus melitensis* could not be recovered two days after inoculation.

E. *Duration of Life of the* Micrococcus melitensis *in Sterilised Tank-water.*

Experiment 1.—February 15, 1905. The same water was used as in the last experiment, but in this case it was sterilised for 30 minutes at 100° C.

Micrococcus melitensis was recovered on the 12th day after inoculation.

F. *Duration of Life of* Micrococcus melitensis *in Tank-mud.*

Experiment 1.—February 15, 1905. Mud, unsterilised. A glass flask was filled to a depth of one inch with fairly liquid mud, which was inoculated with 5 c.c. of a 12-day-old broth culture.

The *Micrococcus melitensis* could not be recovered from this unsterilised mud two days after inoculation.

G. *Duration of Life of* Micrococcus melitensis *in Sterilised Tank-mud.*

Experiment 1.—Mud sterilised.

The *Micrococcus melitensis* was recovered from this sterile mud on the 21st day after inoculation.

H. *Duration of Life of* Micrococcus melitensis *in Unsterilised and Sterile Sea-water.*

Experiment 1.—February 2, 1905. One hundred cubic centimetres of unsterilised sea-water were inoculated with the whole of an eight-day-old agar slope.

The microbe was recovered from non-sterile sea-water one day after inoculation, but not afterwards.

Experiments 2, 3 *and* 4.—February 24, 1905. One hundred cubic centimetres of sea-water were heated to 120° C. in an autoclave for 15 minutes, and were then inoculated with the whole of a nine-day-old agar slope.

Micrococcus melitensis was recovered from No. 2 on the 13th; from No. 3 on the 13th, and from No. 4 on the 12th day after inoculation.

II. THE AMBULATORY TYPE OF CASE IN MEDITERRANEAN OR MALTA FEVER.

By Staff-Surgeon E. A. Shaw, R.N.

(Received November 25, 1905.)

The existence of this type of case amongst a people with whom a specific fever has been for scores of years endemic had long been surmised. The importance of such cases as sources of infection has been amply demonstrated by Koch in his anti-typhoid campaign in the Rhine provinces in 1902, but with regard to Malta Fever the existence of such cases has hitherto been merely a matter of conjecture and not of absolute knowledge.

Accordingly in June of 1905, I set myself to the task of investigating the existence or otherwise of this type of case of Malta Fever amongst the Maltese. For this purpose it was deemed necessary to have available a large number of Maltese actually in full work, each readily identifiable, and under control, so that any one individual could be readily got at for the necessary observations. The method contemplated was to examine the blood of a considerable number for agglutination reaction, and further to make a bacteriological examination of the blood and urine for *Micrococcus melitensis* of such individuals as might present a well-marked agglutination reaction. For obvious reasons women were not contemplated as subjects for the investigation. It was felt to be highly probable that there would be considerable difficulty in getting even a sufficient number of men to submit voluntarily to the necessary procedure.

Having regard to various possibilities, I considered that the Naval Dockyard in Malta, which employs several thousands of Maltese, and gets over the difficulty of a frequently-recurring identity of name by allotting to each man a number, offered the best field for this inquiry. I accordingly obtained from Admiral Bromley, the Admiral-Superintendent of the Dockyard, an authority to proceed as I proposed. It was arranged that the various heads of departments should send batches of men, told off without discrimination, to the Dockyard Surgery on days to be arranged between us for the purpose of having samples of their blood taken for the ascertaining of agglutination reaction.

With the most cordially rendered assistance of Fleet-Surgeon Hardie, R.N., and Surgeon Westcott, R.N., I was able to obtain specimens of blood in capillary tubes from 525 dockyard employés. Each tube had a flag label attached to it bearing the man's name and dockyard number, and corresponding lists of names and numbers were prepared

as the men came up to have their fingers pricked. I next proceeded to examine these 525 samples of blood for agglutination reaction to *Micrococcus melitensis*, using a dilution of 1/30 of each for that purpose. This was a somewhat laborious undertaking, and my thanks are due to Major Horrocks and Captain Kennedy, who very kindly examined between them some 140 of the whole number of samples.

As the result of this preliminary examination it was found that 79 out of the 525, or 15 per cent., gave a distinct agglutination reaction with *Micrococcus melitensis*. Of these 79, a marked reaction was presented by 22, which were accordingly selected for a detailed bacteriological examination of both the blood and urine of the men on the following conditions.

Blood.—Bend of elbow sterilised, 5 c.c. of blood taken from median basilic vein and placed in 80 c.c. of nutrient broth in a flask, this well shaken and placed in incubator at 37° C., daily agitated; sub-cultures made on to agar slopes on 6th and on 11th days. If no result appeared on 14th day, the investigation was abandoned as unfruitful; if a growth appeared, it was put through the usual tests for *Micrococcus melitensis*, and the result recorded. Blood was not taken more than once in each case, owing to the dislike of the subject to the operation.

Urine.—A supply of sterilised test-tubes was daily sent to the Dockyard surgery; the men selected were told to call there each morning at 7 A.M. on entering the dockyard to commence their work. The surgery attendants were instructed (1) to see that each man cleansed the meatus urinarius and glans with 1 in 40 carbolic solution, and (2) to collect the first 1 oz. of urine passed in a suitable vessel for rejection, and the second 1 oz. in one of the sterilised test-tubes, which was then inscribed with the man's number and the date. The samples thus obtained were to be sent to me in the laboratory, where I immediately proceeded to plate each out. From each daily sample of urine two Petri dishes containing nutrose litmus agar (no glucose), of a reaction +10, were inoculated, 1/3 of a c.c. (six drops, about) being distributed over the surface of each with a spreader. These plates were numbered, dated, and incubated at 37° C. for six days. They were then examined and the likely colonies were put through the usual tests for *Micrococcus melitensis*. Where, as in Cases IX and XI, the colonies of this organism were too numerous to be counted individually, the numbers given were arrived at by selecting an average area, counting the colonies contained in 1 sq. cm. of this, and determining the total number of square centimetres covered with colonies. The urines were thus daily examined for 28 successive days, exclusive of Sundays.

I will now describe these 22 cases as briefly as possible. The temperatures given are those of each man for the first few days of the observations, the first being the morning and the second the evening

temperature. All these men were in full work for the whole period of these observations, with the exception of Case I, who was at home once for three days on the sick list. For the temperatures and brief details of each case, my thanks are due to Fleet-Surgeon Hardie, R.N., of H.M. Dockyard at Malta, who tells me that he found it impossible to ascertain definitely what kind of fever it was which some of these men say they had previously had.

Case I.—G. Araci, 4112, age 25, labourer. Had a week's fever about 12 months ago.

Temperatures.—99°/99°·2; 98°·6/99°·4; 99°/99°·8; 99°·2/99°·6; away 3 days; 99°/99°·2.

Blood yielded no *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on July 4.
2 ,, ,, ,, ,, 12.
23 ,, ,, ,, ,, 19.
3 ,, ,, ,, ,, 21.

Case II.—G. Busutil, 1918, age 17, boiler-maker's apprentice. Had fever 13 years ago.

Temperatures. — 98°/99°; 98°·4/99°; 98°·6/98°·2; 98°/98°·8; 98°·4/98°·6; 98°/98°·4; 98°·2/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine ,, ,, ,,

Case III.—G. Ciantar, 3528, aged 38, joiner. Was sick for 2 days 2 months ago.

Temperatures.—99°·8/100°; 99°·6/99°·8; 98°·4/98°·2; 98°·0/98°·8; 98°·0/98°·4; 98°·4/98°·6; 98°·2/98°·4.

Blood yielded *Micrococcus melitensis.*

Urine yielded 1 colony of this organism on July 6.
3 colonies of ,, 7.
5 ,, ,, 8.
3 ,, ,, 13.
10 ,, ,, 15.
3 ,, ,, 17.
5 ,, ,, 18.
10 ,, ,, 19.
6 ,, ,, 21.
1 colony ,, ,, 24.

Case IV.—F. Darmanin, 4221, age 30, hammerman. Had fever 12 years ago.

Temperatures.—99°·8/99°·4; 99°·6/99°·2; 98°·6/98°·0; 98°·2/98°·6; 98°·4/98°·4; 98°·0/98°·2; 98°·2/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on July 14.
1 colony of ,, 21.
9 colonies of ,, 24.

Case V.—C. Cassar, 1203, age 28, assistant fitter. Has had headaches and giddiness for the last 3 months.

Temperatures. — 99°·0/99°·0; 98°·0/98°·2; 98°/98°; 98°·0/98°·2; 98°·0/98°·2; 98°·2/98°·4; 98°·0/98°·4.

Blood yielded no *Micrococcus melitensis.*

Urine „ „

Case VI.—T. Sceberras, 3475, age 35, joiner. Had fever in April and May last.

Temperatures. — 99°/99°; 98°·6/99°·0; 98°·4/98°·2; 98°·0/98°·6; 98°/99°; 98°/98°; 98°·6/98°·2.

Blood yielded no *Micrococcus melitensis.*

Urine „ „

Case VII.—F. Grima, 1686, age 50, founder. No history of fever. Complains of "general debility."

Temperatures. — 100°/101°·2; 99°·4/99°·4; 99°/98°; 98°/98°; 98°·4/98°·0; 98°/98°; 99°·2/100°.

Blood contained *Micrococcus melitensis.*

Urine yielded 9 colonies of	*Micrococcus melitensis*	on July	11.
1 colony	„	„	12.
1	„	„	15.
2 colonies	„	„	20.
13	„	„	21.
3	„	„	25.

Case VIII.—D. Burlo, 1094, age 21, assistant fitter. Had "fever," lasting 15 days 2 years ago.

Temperatures.—98°·0/98°·8; 99°·0/98°·6; 98°·6/98°·2; 98°·4/98°·6; 99°·2/98°·0; 98°·2/98°·2; 98°/98°.

Blood yielded no *Micrococcus melitensis.*

Urine „ „

Case IX.—B. Worley, 1857, age 29, boilermaker. Had fever 10 months ago.

Temperatures.—98°·0/98°·4; 98°·0/98°·4; 98°·2/98°·6; 98°·0/98°·8; 98°·4/98°·4; 98°·0/98°·4; 98°·0/98°·2.

Blood yielded no *Micrococcus melitensis.*

Urine contained *Micrococcus melitensis* every day from July 3 to end of August, usually in very large quantity. It was then arranged to examine it twice weekly; it has been present on every occasion up to date of writing (November 21). The periodical examination is still being continued. Enumerations of the colonies were made on following dates in the manner described:—

July 5,	26,631	colonies of *Micrococcus melitensis*	per c.c. urine.
7,	57	„	„
10,	16,023	„	„
14,	24	„	„
22,	22,869	„	„

July 24,	32,319	colonies of *Micrococcus melitensis* per c.c. urine.
August 9,	9,450	,, ,,
14,	69	,, ,,
26,	381	,, ,,
September 29,	690	,, ,,
October 10,	9,005	,, ,,

This man's urine has been used for various feeding and other experiments with monkeys and goats by both Major Horrocks and myself, and has infected both these species of animal.

CASE X.—V. Borg, 3567, age 34, tailor. Had "fever" for 3 weeks about 10 or 11 months ago.

Temperatures.—99°·0/98°·4; 98°·8/99°·2; 99°·2/98°·8; 98°·6/99°·2; 99°·0/98°·4; 98°·0/98°·2; 98°·4/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

CASE XI.—F. Mallia, 3414, age 31, joiner. Had fever for 4 weeks, commencing May 1, 1905.

Temperatures.—98°·8/99°·0; 98°·6/98°·6; 98°·4/98°·4; 98°·6/98°·0; 98°·2/98°·4; 98°·6/98°·4; 98°·6/98°·2.

Blood contained *Micrococcus melitensis.*

Urine contained this organism every day from July 3 to end of August. During September and October it was plated twice weekly, and only failed to yield *Micrococcus melitensis* on one occasion (September 12), when the plates were bad. The number of colonies per cubic centimetre of urine have not been so numerous as in Case IX, but have varied within wider limits as follows :—

July 3,	39	colonies of *Micrococcus melitensis* per c.c. urine.
11,	291	,, ,,
13,	981	,, ,,
22,	108	,, ,,
24,	1,953	,, ,,
August 16,	6,426	,, ,,
25,	270	,, ,,
September 29,	13,380	,, ,,
October 18,	1,017	,, ,,

This man's urine also has been used for various successful animal infection experiments (q.v.), and up to date of writing (November 21) has continued to yield *Micrococcus melitensis* from each of the bi-weekly samples.

CASE XII.—G. Saccett, 3326, age 15, rivet boy. Had 2 days' illness with headaches 4 months ago.

Temperatures.—98°·8/99°·0; 98°·4/99°·2; 98°·4/98°·6; 98°·2/98°·2; 98°·2/98°·4; 98°/98°; 98°·2/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XIII.—G. Bianco, 2565, age 46, shipwright. Four years ago had fever for 2 months followed by arthritis.

Temperatures.—98°·6/98°·4; 98°·6/98°·4; 99°·0/98°·6; 98°·0/98°·8; 98°·0/99°·0; 98°·2/98°·0; 98°·0/98°·2.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XIV.—G. Cutajar, 3046, age 27, shipwright. States he has never had fever.

Temperatures.—99°·8/99°·2; 98°·0/99°·2; 98°·8/99°·0; 98°·4/98°·4; 98°·2/99°·0; 98°·4/98°·2; 98°·2/99°·0.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XV.—G. de Giovanni, 3022, age 27, shipwright. Three years ago had fever for about 3 weeks.

Temperatures. — 98°·4/98°·4; 98°·0/98°·4; 98°/99°; 98°·4/98°·6; 98°/99°; 98°·2/98°·8; 98°·0/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XVI.—G. Parlar, 3797, age 16, rivet boy. Had slight fever 8 months ago.

Temperatures.—98°·2/99°·0; 98°·6/98°·6; 98°·0/98°·8; 98°·0/99°·2; 98°·0/98°·6; 98°·2/98°·2; 98°/98°.

Blood did not yield *Micrococcus melitensis.*

Urine yielded 2 colonies	of *Micrococcus melitensis*	on August	3.
2	,,	,,	8.
5	,,	,,	14.
7	,,	,,	26.

Case XVII.—Carmelo de Celis, 3796, age 15, rivet boy. Had 10 days' fever a fortnight ago.

Temperatures.—98°·4/100°·4; 98°·2/99°·8; 98°·6/99°·2; 99°·0/99°·8; 98°·8/100°; 98°·4/99°·2; 98°·0/99°·4.

Blood contained *Micrococcus melitensis.*

Urine did not yield this organism.

Case XVIII.—E. Casinguena, 2911, age 33, shipwright. Had 10 weeks' fever 14 months ago.

Temperatures.—98°/98°; 98°·2/98°·4; 98°/98°; 98°·2/98°·4; 98°/98°; 98°·2/98°·6; 98°·0/98°·4.

Blood did not contain *Micrococcus melitensis.*

Urine yielded 1 colony	of *Micrococcus melitensis*	on August	4.
5 colonies	,,	,,	10.
2	,,	,,	16.
3	,,	,,	19.

Case XIX.—A. Ghirsci, 3111, age 40, shipwright. Never had fever.

Temperatures. — 98°/98°; 98°·0/98°·4; 98°·0/98°·8; 98°·6/98°·4; 98°·0/98°·8; 98°/98°; 98°·4/98°·6.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XX.—R. Mamo, 906, age 32, assistant fitter. Had fever 2 years ago for 3 months.

Temperatures. — 98°·0/98°·8; 98°·0/98°·4; 98°/98°; 98°·2/98°·6; 98°·4/98°·2; 98°·0/98°·6; 98°·2/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine yielded 3 colonies of *Micrococcus melitensis* on August 8.
2 ,, ,, 12.
8 ,, ,, 18.

Case XXI.—E. Agius, 2550, age 58, shipwright. Never had fever.

Temperatures. — 99°/99°; 99°·0/99°·4; 99°·8/99°·2; 98°·8/99°·6; 98°·4/99°·2; 98°·6/98°·4; 98°·4/98°·6.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Case XXII.—A. Gatt, 3625, age 49, painter. Had slight fever for about 4 days 2 years ago.

Temperatures. — 99°/99°; 98°·4/99°·6; 98°·4/99°·2; 98°·8/99°·0; 98°·4/99°·0; 98°·8/99°·2; 98°·4/98°·4.

Blood did not yield *Micrococcus melitensis.*

Urine ,, ,,

Results.—Thus all 22 of these cases gave a marked agglutination reaction with *Micrococcus melitensis.* From three of them (Cases III, VII, and XI) the parasite was recovered from both blood and urine. From one it was obtained from the blood only (Case XVII), and from six (Cases I, IV, IX, XVI, XVIII, and XX) from the urine only. All these men were up and about and in full work during the period of observation.

Though all these men presented such a marked agglutination reaction as to make it a certainty, they had all had Malta Fever some time or other; Cases VII, XIV, XIX, and XXI deny ever having had it at all, although from Case VII *Micrococcus melitensis* was recovered from both blood and urine. As regards temperatures, it will be seen there was a slight rise above the normal in three of the four (III, VII and XVII), from whose blood the *Micrococcus melitensis* was recovered; that of the fourth (Case XI) being practically continuously normal. While of those six from whom the urine alone yielded the parasite, the temperatures of two (Cases I and IV) were slightly raised, those of the remaining four (Cases IX, XVI, XVIII and XX) being practically normal. The infectivity of the urines of these cases is shown by the fact that a

few cubic centimetres of the urine of No. 9, injected subcutaneously into a monkey, gave rise to a typical attack of Malta Fever, with recovery of *Micrococcus melitensis* from the blood and organs, and also by the successful feeding experiments on both monkeys and goats (q.v.) which were carried on separately by Major Horrocks and myself with the urines of Cases IX and XI, which excreted *Micrococcus melitensis* on a remarkable scale both in regard to amount and duration.

Conclusions 1.—That the existence of ambulatory cases is now proved.

2.—That their urine contains *Micrococcus melitensis*, in large quantity and for prolonged periods, is proved.

3.—That their urine is a source of infection, at least to monkeys and goats, is proved.

III. MEDITERRANEAN FEVER IN GOATS, COWS, AND OTHER ANIMALS.

By Staff-Surgeon E. A. SHAW, R.N.

(Received November 25, 1905.)

I. GOATS.

A.—*Experimental.*

To determine experimentally to what degree goats, which are so numerous in Malta, are susceptible to Malta Fever, I determined, in July, 1904, to inject cultures of *Micrococcus melitensis* subcutaneously into these animals. Thinking that possibly there might be a difference of susceptibility between the mature and immature animal, I began with experiments on a goat and a kid. On July 30, 1904, a female goat, two years old, and a female kid, three months old, were purchased, their blood was examined for agglutination reaction to *Micrococcus melitensis* (which was found to be nil), and they were kept under observation for a week. They were then dealt with as follows:—*

Experiment 1.—Goat ♀. July 30, 1904, no agglutination reaction; temperature normal, practically between 101° and 102° F. till August 8, 1904. Injected subcutaneously at noon of that day into left flank an emulsion of the six-day growth of *Micrococcus melitensis* on six agar slopes, second generation from spleen of human fatal case. This caused a rise of temperature of 3°·8 F., from 102° to 105°·9 F. on the 9th, and 107°·2 on the 10th of August, then gradually falling back to normal by August 14.

Agglutination.—Agglutination reaction was first present on August 13, 1 in 30; rising to 1 in 200 on August 14, and 1 in 1800 on August 20, on which date the goat received a second injection of the growth from four similar agar slopes of *Micrococcus melitensis*, which caused a similar rise of temperature for three days. On August 29 it received a third injection of emulsified growth from four more slopes. On August 30 the agglutination reaction was 1 in 2200, and on September 5, 1 in 3200. All these were visible under ⅓-in. objective in 15 minutes.

* [It should be stated that the first of these experiments was briefly described by the author in the manuscript of the Report by him published in the first Part of the Reports of this Commission (March, 1905), but the paragraph was deleted at his request, as the observations were, in his opinion, still incomplete, though he recognised and stated that the "goats, which are extremely numerous in Malta, might possibly be instrumental in transmitting the infection of Malta Fever."—Sec. R.S.]

Urine.—This was plated daily, after having been drawn off into a sterile vessel by a sterile catheter, which I passed myself from August 25 to September 6, ½ c.c. of urine being distributed over the surface of glucose nutrose litmus agar contained in Petri dishes, which were incubated for six days at 37° C. On September 6, 1904, I went on three weeks' leave. On my return experiments were resumed by me on September 30. A fourth subcutaneous injection of *Micrococcus melitensis* growth from six agar slopes as before was made on October 10, with the idea of giving the goats' kidneys plenty of the parasite to excrete. The experiment was continued till October 31 and was then given up, no *Micrococcus melitensis* having been at any time recovered from the urine of this animal.

Milk.—This was first plated for recovery of possible *Micrococcus melitensis* on August 28, 1904; but on September 1 the plates were found to be completely overgrown with a *Staphylococcus*, and on centrifugalising the milk from each udder and making film preparations from the deposit, I recognised pus in the milk from each udder. On August 28 also, feeding experiments with the milk of this goat were commenced on a healthy monkey (No. 61), a stomach tube being passed and 1 oz. given on this date, 2 ozs. on August 29, 4 ozs. on the 30th, and 4 ozs. on the 31st; but such severe diarrhœa was developed that no more milk was given after the last date. This monkey, unfortunately, succumbed on September 4. The usual inoculations were made from its organs and heart's blood into broth, and on to agar slopes, but no *Micrococcus melitensis* was recovered. The milk of this goat was examined from time to time, but the pus persisted till April 25, 1905, by which time the milk was "drying up." It may be noticed in passing that suppurative mastitis is by no means infrequent amongst goats in Malta and causes, from time to time, outbreaks of illness amongst children (see *Health Reports of Malta*). In June, 1905, the secretion of milk had practically ceased and pus was no longer present in the altered secretion, now thick, ropy, brownish and gelatinous; which, on being plated on June 24, yielded colonies of *Micrococcus melitensis* in abundance.*

Blood.—The agglutination reaction continued to increase, being 1 in 3200 on September 30, 1904, and 1 in 4500 on October 18. It then began to diminish, being 1 in 3000 on November 1, 1904, 1 in 3000 on January 3, 1905, 1 in 3000 on February 27, 1905, and after this stationary period going down to 1 in 2000 on April 25, 1905, and 1 in 1500 on June 12, 1905.

Micrococcus melitensis was recovered from the blood (5 c.c.) of the

* [Major Horrocks had previously recovered *Micrococcus melitensis* from apparently normal goats, and had shown the plates to Staff-Surgeon Shaw.—Sec. R.S.]

jugular vein on November 7, 1904, and again from the blood of the same vein on June 27, 1905.

Experiment 2.—Goat, juv. The kid of three months, purchased at the same time as the goat, received injections of *Micrococcus melitensis* on the same dates as the goat, but only in half the quantities.

Its urine was plated on the same days above detailed for the goat but it never yielded any *Micrococcus melitensis.* Its agglutination reaction was similarly examined with the following results :—

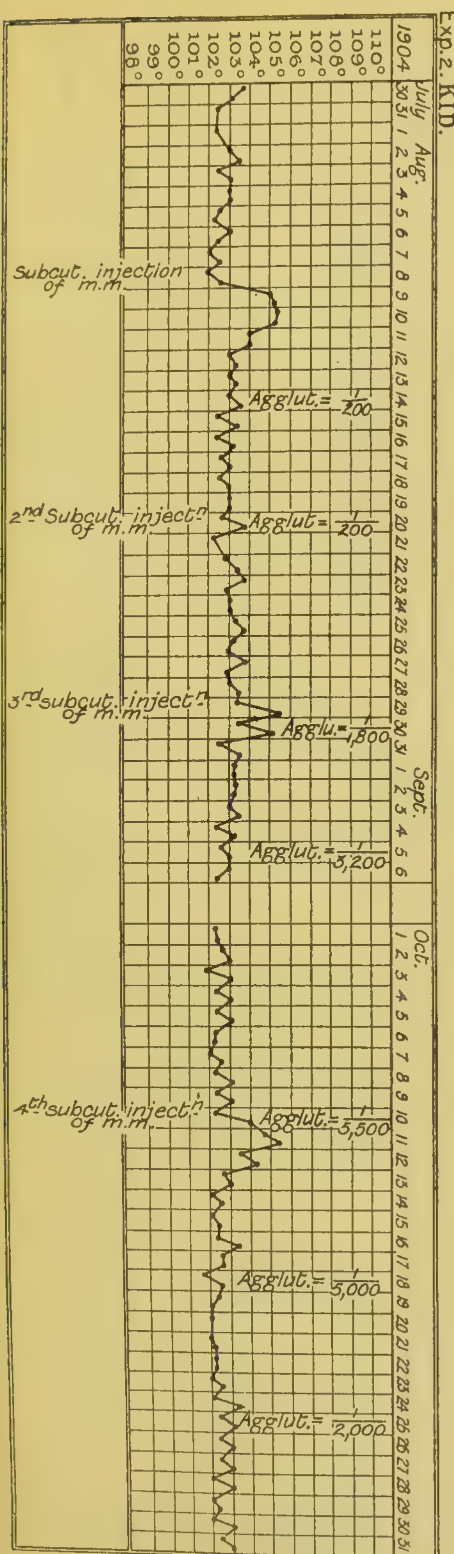
1904—		
July	30	Nil
August	14	1/200
,,	20	1/200
,,	30	1/1800
September	5	1/3200
,,	30	1/3200
October	11	1/5500
,,	18	1/5000
,,	25	1/2000
November	1	1/3000
1905—		
January	3	1/2000
February	27	1/1500
April	25	1/1500

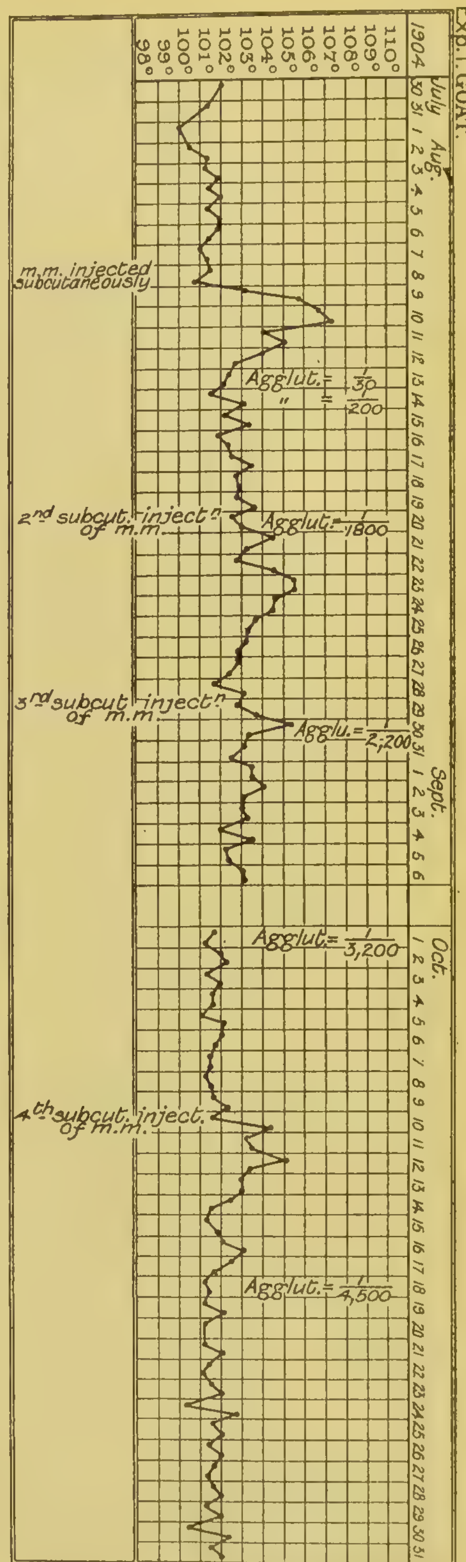
These figures follow closely those obtained from the goat, but rise somewhat higher in degree. *Micrococcus melitensis* was recovered from the blood of the kid in November, 1904, and in June, 1905.

From an inspection of the accompanying charts it will be seen that the rise of temperature following each injection is only temporary, lasting but three or four days, thus decidedly differing from the prolonged wave of fever produced in monkeys by a similar procedure, and suggesting a sort of racial tolerance of this infection on the part of the Maltese goat. It was thus proved by the development of a high agglutination reaction in August, 1904, and by the recovery of living *Micrococcus melitensis* from the blood in November, 1904, that the goat is at least experimentally susceptible to Mediterranean Fever.

B. *Natural.*

Dr. Zammit in June, 1905, found that the blood of four goats (out of six purchased for further experimentation) reacted to *Micrococcus melitensis* at the time of purchase. This observation having been confirmed by Major Horrocks and myself, and the micro-organism having also been recovered from the milk of one of these animals, the question of the agency of the goat in diffusing the *Micrococcus melitensis* was brought from the domain of speculative experiment


Exp. 2. KID.
1904
July
Aug.
Sept.
Oct.
110° 109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98°
Subcut. injection of m.m.
Agglut. = 1/200
2nd Subcut. inject.n of m.m.
Agglut = 1/200
3rd subcut. inject.n of m.m.
Agglu. = 1/1,800
Agglut. = 1/3,200
4th subcut. inject.n of m.m.
Agglut. = 1/5,500
Agglut. = 1/5,000
Agglut. = 1/2,000


Exp. 1. GOAT.
1904
July
Aug.
Sept.
Oct.
110° 109° 108° 107° 106° 105° 104° 103° 102° 101° 100° 99° 98°
m.m. injected subcutaneously
Agglut. = 1/30
" = 1/200
2nd subcut. inject.n of m.m.
Agglut. = 1/1800
3rd subcut. inject.n of m.m.
Agglu. = 1/2,200
Agglut. = 1/3,200
4th subcut. inject. of m.m.
Agglut. = 1/4,500

into the range of everyday life.* And after discussing the matter with Deputy Inspector-General Bentham, of the Naval Hospital at Bighi, we decided that I should at once begin an examination of all the goats supplying milk to this hospital.

The method of procedure adopted was as follows :—The goats were taken in batches of 12 to 16 at a time. The milk contractor's son took down in Maltese the name and description of each goat, which was numbered. A little blood was taken from the goat's ear in a capillary tube for examination for agglutination, and at the same time 40 to 50 c.c. of milk were drawn off into a sterile test-tube; to both of these the same number was attached, the intention being to subsequently eliminate all the goats which might be found infected. After examination of the blood for agglutination reaction, the milk of each goat which reacted was centrifugalised, and the centrifuged portion was plated on nutrose-litmus-agar, $\frac{1}{4}$ c.c. being distributed over the surface of each Petri dish. These were incubated at 37° C., and were then examined for *Micrococcus melitensis* colonies in the usual way. Four to six plates were used for each milk thus treated.

The examination was begun on June 29. Surgeon Whiteside, R.N., was so good as to collect the necessary material from the goats at times when I was unable to attend, and he also helped with the agglutination reactions. These were done in two stages, the first to eliminate the non-agglutinating bloods (or milks), the second to determine highest dilution giving agglutination of the remainder. All went well for a few days, until the goat-herds, who had all along looked unhappy over the pricking of their goats' ears for blood, broke out into open rebellion, and henceforth we had to be content with only milk. This necessitated either plating every milk or ascertaining the existence of the agglutination reaction with it. I have already mentioned the excretion of agglutinins in the urine (Part III of these reports, p. 47). It seemed not unlikely that they would be found to be present in the milk of infected animals. I accordingly put up specimens of such milk, centrifuged and uncentrifuged, diluted and undiluted, with freshly prepared emulsion of *Micrococcus melitensis* in drops on slides in a moist chamber, with controls of normal milk, and left them for an hour. I then examined them under the microscope and found distinct agglutinations with the infected milks; most palpably in the uncentrifuged specimens, the appearance in the centrifuged series being somewhat masked by *débris* of various sorts.

* Major Horrocks states that Dr. Zammit and he found that five of the normal goats reacted, and that he recovered *Micrococcus melitensis* from the milk of all of them but one. He remarks, further, that "the fact that the milk of infected goats causes agglutination of the *Micrococcus melitensis* was first shown by Zammit, and in the combined paper by Kennedy and myself the reaction is called Zammit's test." —[Sec. R.S.]

When the milk was allowed to stand in the sterile test-tubes for a couple of hours, a considerable layer of cream came to the top and a deposit of *débris* gathered at the bottom. By passing a pipette down to the middle of the column, aspirating milk from there, withdrawing the pipette and then breaking off the capillary end of the pipette well above the adherent cream, I could obtain a specimen of milk almost free from *débris* and with relatively few oil globules, in which the presence or absence of agglutination was fairly easily determinable. This method was, therefore, perforce adopted for the ascertaining of agglutination reaction in the batches of goats examined on July 13 and 14, a 24-hour limit for contact of diluted milk and emulsion being adopted for determination of highest dilution giving agglutination.

The details of these examinations of the goats supplying milk to Bighi Hospital in June and July, 1905, are subjoined.

June 29. Twelve goats examined. Agglutination reaction found in blood of three: No. 4, in a dilution of 1 in 30; No. 8, 1 in 100; No. 10, 1 in 60. Milks of all three centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 8 only (49 colonies).

July 3. Second batch of 12 goats examined. Agglutination reaction found in blood of five: No. 4, 1 in 100; No. 5, 1 in 60; No. 6, 1 in 60; No. 8, 1 in 30; No. 9, 1 in 30. Milks of all these five centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 5 (38 colonies), and No. 6 (728 colonies).

July 6. Third batch of 16 goats examined. Agglutination reaction found in blood of three: No. 1, 1 in 100; No. 3, 1 in 60; No. 14, 1 in 160. Milks of these three centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 3 (six colonies).

July 7. Fourth batch of 12 goats examined. Agglutination reaction found in blood of three: No. 5, 1 in 30; No. 7, 1 in 30; No. 10, 1 in 30. Milks of these three centrifugalised, plated, and incubated. No *Micrococcus melitensis* recovered from any.

July 10. Fifth batch of 12 goats examined. Agglutination-reaction found in blood of six: No. 1, 1 in 60; No. 5, 1 in 200; No. 7, 1 in 200; No. 8, 1 in 60; No. 9, 1 in 60. Milks of these six centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered and verified from No. 1 (10 colonies) and from No. 7 (seven colonies).

July 13. Sixth batch of 15 goats examined. Agglutination reaction found in milk of four: No. 2, 1 in 100 after 24 hours' contact in moist chamber; No. 11, 1 in 60; No. 14, 1 in 30; and No. 15, 1 in 30, all under the same conditions. Milks of these four centrifugalised, plated, and incubated. *Micrococcus melitensis* recovered from No. 2 (15 colonies) and No. 11 (five colonies).

July 14. Seventh batch of 12 goats examined. Agglutination

reaction found in milk of six: No. 1, 1 in 150 after 24 hours' contact in moist chamber; No. 2, 1 in 160; No. 4, 1 in 30; No. 7, 1 in 30; No. 9, 1 in 30; No. 12, 1 in 30. *Micrococcus melitensis* was recovered and verified only from No. 4 (two colonies).

For convenience of reference, these results may be arranged in tabular form, thus:—

Date.	No. of goats examined.	No. presenting agglutination reaction.	Distinguishing No. of the goats of each batch whose milk yielded *Micrococcus melitensis*.	Agglutination limit of latter.	No. of *Micrococcus melitensis* colonies recovered.
29 June...	12	3	No. 8	1 in 100	49
3 July...	12	5	No. 5	1 „ 60	38
			No. 6	1 „ 60	728
6 „ ...	16	3	No. 3	1 „ 60	6
7 „ ...	12	3	None	—	—
10 „ ...	12	6	No. 1	1 in 60	10
			No. 7	1 „ 200	7
13 „ ...	15	4	No. 2	1 „ 100	15
			No. 11	1 „ 60	5
14 „ ...	12	6	No. 4	1 „ 30	2
Totals...	91	30	9	—	—

Thus 91 goats were examined, of these, 30 presented the agglutinating reaction on *Micrococcus melitensis*, and the milk of these 30 was examined culturally for the parasite, this organism being recovered from the milk of nine of them. The implicated animals were eliminated from the herds supplying the Naval Hospital, and the most stringent measures were taken to ensure that all milk entering the hospital gates was forthwith boiled. It will be interesting to see whether any alteration takes place in the future incidence of cases of fever developing in this hospital.

It will be noticed that in these naturally-infected goats the agglutination limit is low, the highest found being 1 in 200, whereas in the experimentally infected animal it was found as high as 1 in 4500. No indication has been observed of any relation between agglutination value and the number of colonies of *Micrococcus melitensis* yielded by the milk.

The number of organisms other than *Micrococcus melitensis* found in the milk from these 30 goats varied enormously, though the milk was collected under precisely similar conditions from all. In some cases $\frac{1}{4}$ c.c. of milk would contain but two or three organisms, in others they would be present by the thousand. Time did not admit of a detailed examination being made of these.

The infectivity of the milks obtained from the goats which were the subjects of the experiments here detailed was investigated as follows:—

A monkey received from Genoa on July 12 was kept under observation for a week, its temperature was found to be normal during this period, and its blood did not react to *Micrococcus melitensis.* On July 20, the colonies of this micro-organism obtained from No. 2 goat's milk, plated July 13, were emulsified in a little normal saline solution. The monkey being held on its back, three drops of this emulsion were dropped down each nostril with a capillary pipette. The animal developed a typical attack of Mediterranean Fever, its blood gave agglutination reaction to *Micrococcus melitensis* first on August 3; 14 days after infection in a dilution of 1 in 30, running up to 1 in 320 on August 6, and 1 in 960 on August 10; *Micrococcus melitensis* was recovered from its blood during life on August 22, and from its lymphatic glands after death on October 18.

II. Cows.

As it seemed by no means impossible that cows also might be found to be infected with Mediterranean Fever, I determined to investigate this question. Not many milch cows are to be seen in the Island of Malta, there being no pasturage for them. Their owners keep them shut up, some of their stables being most scrupulously clean, while others are much the reverse. The cows seldom get outside. There is a considerable demand for their milk, especially on the part of the resident English population, many of whom dislike the taste of goat's milk, while others object to receive milk from an animal which has just previously been lying down in the street with its udders and teats in close contact with the excreta, liquid and solid, of the various animals, higher and lower.

To Mr. A. M. Macfarlane, M.R.C.V.S., Veterinary Surgeon to the Malta Government, who helped me to procure the necessary materials for bacteriological examination, my warmest thanks are due for the kindness with which he took me round to the various farms, used his influence with the owners of the cattle, and personally assisted in collecting the necessary material for examination.

The method of investigation determined on was as follows: At each of the various farms visited, blood was taken from the cows, each animal being assigned a number, which was cut deep in Roman numerals into the hair of its back. The samples of blood were correspondingly numbered, and were subsequently examined for agglutination reaction to *Micrococcus melitensis.* The numbers of the cows, at each farm, giving this reaction, were sent with a daily supply of sterilised test tubes to Mr. Macfarlane, who undertook the collection

of a daily sample of milk from each of the cows specified. These milks were received at the laboratory about an hour after they were drawn. They were at once centrifugalised, and the deposit was plated on nutrose-litmus-agar in Petri dishes, three plates to each sample. These were incubated five days at 37° C., and were examined in the usual way for colonies of the micro-organism. The milks were thus treated daily from August 1 to August 24, 1905, inclusive, with the following results:—

G. F. of Tarxien.—Nine cows, of which three presented agglutination reaction to *Micrococcus melitensis* as follows: No. 3, 1 in 30; this being a heifer, no milk was attainable, and no other form of examination was permitted. No. 4 agglutinated *Micrococcus melitensis* in a dilution of 1 in 30, and No. 7 in a dilution of 1 in 60. The milks of the two latter were daily plated for 24 consecutive days. Cow No. 7 never yielded any colonies of parasite, but these were found in the milk of Cow No. 4, as follows:—

Plates of	7th	August	5	colonies of	*Micrococcus melitensis.*
,,	8th	,,	7	,,	,,
,,	12th	,,	7	,,	,,
,,	16th	,,	3	,,	,,
,,	19th	,,	40	,,	,,
,,	20th	,,	3	,,	,,
,,	21st	,,	39	,,	,,
,,	24th	,,	19	,,	,,

none being found on the other days.

F. G. of Hamrun.—Nine cows, of which five presented agglutination reaction as follows:—

No. 1	agglutinated	1 in 30.
,, 4	,,	1 in 800.
,, 8	,,	1 in 200.
,, 9	,,	1 in 30.

Of these Cow No. 9 was ailing and not yielding any milk. The milks of the others were plated daily. Nos. 1 and 4 never yielded any colonies of *Micrococcus melitensis*, which, however, were found in the milk of Cow No. 8, as follows:—

Plates of	11th	August,	63	colonies of	*Micrococcus melitensis.*
,,	12th	,,	9	,,	,,
,,	13th	,,	31	,,	,,
,,	16th	,,	23	,,	,,
,,	18th	,,	7	,,	,,
,,	19th	,,	13	,,	,,
,,	20th	,,	231	,,	,,

none being found on the other days.

S. G. of Hamrun.—Six cows, none of which presented any agglutination reaction.

C. G. of Hamrun.—Three cows, of which only 1 presented an agglutination reaction in a dilution of 1 in 30. The milk of this animal was daily examined, but never presented any *Micrococcus melitensis.*

C. C. of St. Julian's.—Four cows, of which No. 2 presented a high agglutination reaction, this being present in a dilution of 1 in 1000. Unfortunately this animal happened to be a heifer, so again no further material for bacteriological examination was procurable.

S. M. of Imsieral.—Two cows, neither of which presented any agglutination reaction to *Micrococcus melitensis.*

Result.—Thirty-three cows examined. Ten of these presented an agglutination reaction to *Micrococcus melitensis*, varying from 1 in 30 to 1 in 1000. From the milk of two of these cows *Micrococcus melitensis* was isolated.

III. Other Animals.

During the months of July and August, 1905, I examined specimens of blood kindly procured for me by Mr. Macfarlane, M.R.C.V.S., from 31 bullocks which were ailing in a vague indefinite sort of way, and which he thought might possibly be infected with Malta Fever. Of these, five presented a very faint agglutination reaction. None of these animals had been in the island over three months.

I also examined several times the blood of two dogs similarly suspected. Neither of these presented any reaction to *Micrococcus melitensis.*

Remarks.

The manner in which animals become infected with the virus of Mediterranean Fever is a matter of considerable interest and importance. Up to the present all the evidence available points to their food as being the main vehicle of infection. The feeding experiments carried on by Major Horrocks and by myself show conclusively that monkeys and goats may be thus infected. Besides the very obvious way of infection of the young through their mothers' milk, the successful result of various feeding experiments with food soiled, directly and indirectly, with the urine of two ambulatory cases of Mediterranean Fever which I discovered working in the Dockyard, and in whose urine living *Micrococcus melitensis* was being excreted, indicates another way in which these animals may be infected while feeding Goats may be seen any day in the streets of the chief city of the Island of Malta feeding on filth and rubbish of every possible variety, some of it visibly saturated with urine, animal and human. Among

the lower class Maltese, as above stated, workmen have been found who void living *Micrococcus melitensis* in their urine, as do a certain number of the infected goats. Thus the path of this manner of infection becomes clear. Having satisfied their hunger in this manner, the goats lie down in the streets to digest their meal with their teats and udders often in contact with the ordure of the gutters and roads, till they are kicked up by the goat-herd to be milked into the vessel brought to the doors of the adjacent houses by their occupants. It is hence not to be wondered at that these animals frequently suffer also from suppurative mastitis, and give milk containing pus. In the Health Reports of the Malta Government may be seen reports of outbreaks of illness amongst children directly traced to this cause by their medical officers.

With regard to cows, the evidence is not quite so clear. Kept shut up in "shippens," and seldom allowed outside, they have their food brought to them, but as this food is composed of vegetable and other refuse collected from every possible source and situation, it is easy to understand that they can hardly escape from receiving infected food from time to time.

Summary.

1. The susceptibility of goats to experimental infection by *Micrococcus melitensis* was ascertained by me in the summer of 1904, and is here further demonstrated.

2. The persistence of living *Micrococci* in the blood of a goat for seven months has been proved. The bearing of this observation on the preparation of a therapeutic serum is obvious.

3. Of 91 goats in full milk, 30 were found to have become infected with Mediterranean Fever at some time or other, as shown by their agglutinating power on *Micrococcus melitensis*. Living examples of the micro-organism were recovered from the milk of nine of these, and its infectivity was demonstrated on a monkey.

4. Of 33 cows examined, 10 were found to have become infected with Mediterranean Fever, and living *Micrococcus melitensis* was recovered from the milk of two of these.

5. Of 31 bullocks examined, five were found to show a faint agglutination reaction, which may indicate that they had become infected with Malta Fever.

6. Of two ailing dogs, thought to be suffering from this fever, neither was found to be infected.

IV. ON THE DURATION OF LIFE OF THE *MICROCOCCUS MELITENSIS* IN UNSTERILISED SOIL.

By Major W. H. Horrocks, R.A.M.C.

(Received December 16, 1905.)

In Part I of the "Reports of the Mediterranean Fever Commission," studies were described as to the duration of life of the *Micrococcus melitensis* in sterilised soils, and it was shown that not only did the organism survive in these soils, but also that it was possible to infect monkeys by causing them to inhale infected dust. These results having been obtained, it became necessary to ascertain whether the microbe could live in unsterilised dust such as is found in the streets of Malta, and also in earth fouled with excrementitious material.

Experiment I.

To ascertain the duration of life of the *Micrococcus melitensis* in dust collected from the Strada Mercanti, Malta.

On May 19 dust was collected from the street and placed in sterile test-tubes. A loopful of the dust was then added to varying quantities of water contained in sterile watch glasses. Surface plates were next made from these dilutions, and the dilution determined which produced colonies sufficiently discrete, after four days' incubation, to enable the *Micrococcus melitensis* to be detected should it be present.

On May 22 an emulsion of an agar growth of the *Micrococcus melitensis* in sterile water was added to the street dust so as to wet every particle, the tubes were then placed in the laboratory cupboard and allowed to dry naturally.

On May 27 the dilution of the soil determined above was plated on the surface of 12 glucose-litmus-nutrose-agar plates. Typical colonies, reacting to all the tests, were recovered.

On June 13 the *Micrococcus melitensis* was again isolated.

On June 19 a successful recovery was also made, but after this all attempts to isolate the microbe were unsuccessful.

Result.—The *Micrococcus melitensis* lived for 28 days in natural dust collected from the Strada Mercanti.

Experiment II.

To ascertain the duration of life of the *Micrococcus melitensis* in unsterile building dust.

This particular dust was selected as it is often polluted by the workmen during building operations, and, being very light, is easily blown about the streets.

On May 22 the dust was placed in sterile test-tubes, and then thoroughly moistened with an emulsion of an agar growth of the

Micrococcus melitensis in sterile water. As in Experiment I, trial plates were made to ascertain the quantity of soil which would produce discrete colonies on surface glucose-litmus-nutrose-agar plates.

On May 24 and 27, and on June 2, 5, 9, 13, and 19 the *Micrococcus melitensis* was isolated from the soil, but all the attempts to recover it at later dates proved unsuccessful.

Result.—The *Micrococcus melitensis* lived for 28 days in the natural building dust found in the streets of Valetta.

Experiment III.

To ascertain the duration in life in soil of a culture derived from *Micrococcus melitensis* which had assumed a saprophytic existence for some seven weeks.

It was thought that a *Micrococcus melitensis*, which had apparently become accommodated to conditions of life external to the human body, might live for a much longer period in soil than a culture directly isolated from the spleen of a Mediterranean Fever patient. Accordingly, on June 22, a culture of the microbe, which had been isolated from a sample of tap-water to which it had been added seven weeks previously, was made into an emulsion with water and then added to dust swept up from the Strada Mercanti. The same procedure was followed as in Experiment II. The *Micrococcus melitensis* was recovered on the twenty-fifth day after the commencement of the experiment, but not at a later date.

Result.—A culture of a *Micrococcus melitensis*, which had already assumed a saprophytic existence, did not appear to live longer in soil than a culture freshly isolated from the body of Mediterranean Fever patients.

Experiment IV.

To ascertain the duration of life of the *Micrococcus melitensis* in non-sterile manured garden soil.

Soil obtained from a garden which had been recently manured was placed in test-tubes, and then thoroughly wetted with an emulsion in water of an agar culture of *Micrococcus melitensis* isolated from a case of Mediterranean Fever. The same procedure was followed as in Experiments II and III, but, owing to the foul condition of the soil, it was found that only a few particles of soil could be used to make a workable dilution. The microbe was recovered five days after the inoculation was made.

Experiment V.

This was a repetition of Experiment IV. The *Micrococcus melitensis* survived for 20 days.

Having ascertained that the *Micrococcus melitensis* could live for three to four weeks in polluted soils, it appeared desirable to ascertain

whether the *Micrococcus melitensis* could be recovered from a soil infected with the urine of Mediterranean Fever patients. Accordingly, a urine containing from 10,000 to 30,000 micrococci per cubic centimetre was added to building dust and to dust swept up from the Strada Mercanti, and attempts were made to isolate the specific organism by the procedure already detailed. Unfortunately, all the experiments failed, and the reason is not far to seek. Polluted soils contain from 5,000,000 to 50,000,000 microbes per gramme, and taking the urine at its richest and the soil at its lowest computation, there would be only 3 of the specific micrococci to 500 of the soil microbes. A plate containing 500 colonies is far too crowded to allow of the *Micrococcus melitensis* being isolated, as, after four days' incubation at 37° C., such a plate is completely overgrown. Further dilutions were attempted, but the *Micrococcus melitensis* could not be recovered.

Experiments were then made to ascertain the duration of life of the *Micrococcus melitensis* when a sterilised soil is infected with the urine from Mediterranean Fever patients. The same procedure was followed as in the other experiments, and the *Micrococcus melitensis* was readily isolated after 24 hours, but not at a later date. It was found that the saprophytic microbes in the urine rapidly multiplied in the soils experimented with, and after 48 hours the plates became unworkable unless a dilution of the soil, which practically precluded all hope of recovering the *Micrococcus melitensis*, was employed.

Experiments made to Determine whether it is possible to Infect Animals with Dust Polluted by Urine of Mediterranean Fever Patients.

In the Report of the Commission, Part I, experiments were related which showed that monkeys could be infected by dust artificially inoculated with large quantities of the *Micrococcus melitensis*, and in view of the "dust theory" in relation to the question of the infection of human beings, it appeared important to repeat the experiments, using, however, a dust infected with urine containing the *Micrococcus melitensis*. Such experiments would be the nearest approach that could be made to the conditions actually occurring in Nature.

Experiment I.—Infected Dust blown into the Throat and added to Food.

Monkey No. 111 was kept under observation for some 14 days, and its temperature taken morning and evening. Its blood was also repeatedly examined for reaction with the *Micrococcus melitensis*. The animal appearing perfectly well, the experiment was commenced on July 21, when dust from the Strada Mercanti, infected with urine from Case No. XI (Shaw), and then dried for four days at 37° C., was blown into the pharynx. On the next day a little of the dust was mixed with a feed of boiled rice. The same procedure was

followed until August 9, when, no trace of infection having appeared, it was determined to dry the dust for only 24 hours at 37° C., as it was thought that the prolonged drying in the incubator might have destroyed the virulence of the microbe. On August 13 artificially dried dust was discarded, and dust dried naturally at the room temperature employed. On August 18 the monkey was seized with an acute attack of diarrhœa, and died on the 22nd. At the *post-mortem* examination nothing abnormal was noticed. Cultures were made from the spleen, liver, kidneys, heart's blood, mesenteric, femoral, and axillary glands. All the cultures, however, proved to be sterile.

Experiment II.—Infected Dust blown in the Nostril.

Monkey No. 112 was kept under observation and examined as in the previous experiment. On July 22 sterile building dust, infected with urine of Case XI, and dried artificially, was injected into the nostril. The same dust was injected daily until July 26, when a dust infected with the mixed urine of Cases IX and XI was employed. The injection of this dust once a day having also failed to produce any sign of infection, on August 9 a dust dried at the laboratory temperature was used. On August 23 the monkey appeared very ill, and refused his food; there was, however, no fever, and the blood showed no signs of a reaction with the *Micrococcus melitensis*. The dust injections were discontinued, and the monkey slowly improved, but he never regained his former sleek appearance.

On October 15 the blood diluted 1/10 gave a positive reaction.

On October 18 severe dropsy developed, and the monkey, being seriously ill, was killed with chloroform. Nothing abnormal was found at the *post-mortem* examination. Cultures were made from the spleen, liver, kidneys, bile, blood, and glands, but no signs of the *Micrococcus melitensis* were discovered.

Experiment III.—Infected Dry Dust added to Food.

Monkey No. 113 was kept under observation for a fortnight, and its blood was repeatedly tested as to agglutination with the *Micrococcus melitensis*. On July 24 dust infected with urine of Case XI, and dried naturally for four days, was added to the food.

On July 26 dust infected with the mixed urine of Cases IX and XI was added to the food. The feeding was continued daily until August 6, when the monkey was seized with violent vomiting and diarrhœa, and died on the following morning. During the experiment the blood was repeatedly examined, but never showed the slightest trace of a reaction with the *Micrococcus melitensis*. At the *post-mortem* examination fluid was found in the peritoneum and pericardium; the liver, spleen, and kidneys appeared congested. Cultures were made

from the spleen, liver, kidneys, bile, heart's blood, and glands. No signs of the *Micrococcus melitensis* were detected.

Experiment IV.—Infected Dry Dust added to Food.

Monkey No. 114 was used for this experiment, preliminary observation having shown that it was perfectly healthy. On July 24 dust infected with the urine of Case XI, and dried naturally for 10 days, was added to the food. The feeding was continued daily until August 9, when, owing to the high external temperature, it was found possible to dry the soil in 24 hours. Feeding with this soil was continued until September 17. The blood was examined weekly from the commencement of the feeding, but never showed the slightest trace of a reaction with the *Micrococcus melitensis*. The monkey is still under observation, and appears in perfect health.

Remarks.—Though the attempts to infect monkeys with dust polluted with urine from a case of Mediterranean Fever have failed, the histories of Goats Nos. 13 and 14 show that it is possible to infect these animals in this manner. The ingestion of polluted soils gave rise to violent vomiting and diarrhœa in the case of the three out of the four monkeys experimented upon, and this disturbance of the digestive tract may possibly account for the failure of the experiments. Monkey No. 114 may have been insusceptible. Monkeys vary considerably in their susceptibility to infection; No. 110, mentioned in later experiments, could not be infected, though it received the growth on an agar slope subcutaneously on six separate occasions.

Summary.

1. The *Micrococcus melitensis* survived for 28 days in natural dust collected from the Strada Mercanti, Malta.

2. The *Micrococcus melitensis* survived for 28 days in the natural building dust found in the streets of Valletta, Malta.

3. A sub-culture from a *Micrococcus melitensis*, which had assumed a saprophytic existence for several weeks in water, did not appear to live longer in soil than a culture freshly isolated from the body of a Mediterranean Fever patient.

4. The *Micrococcus melitensis* survived for 20 days in an unsterilised manured garden soil.

5. It has not been found possible to infect monkeys with dust polluted with urine from Mediterranean Fever patients and then thoroughly dried. Goats, however, can be infected in this manner.

V. CONTACT EXPERIMENTS.

By Major W. H. Horrocks, R.A.M.C.

(Received December 16, 1905.)

In the first report of the Mediterranean Fever Commission a description was given of an experiment in which a healthy monkey living between two infected monkeys became infected with the *Micrococcus melitensis*.

The infection might have occurred in the following ways, *i.e.*, (*a*) by direct skin contact; (*b*) by placing in its mouth paws fouled with urine excreted by its neighbours; (*c*) by means of mosquitoes; (*d*) by ecto-parasites passing from the skin of the infected monkeys to the healthy monkey.

Experiments were devised in order to ascertain which of the above possible causes had produced the infection. In the first experiment a healthy monkey was placed in a box next to infected monkeys, and the boxes were surrounded by mosquito-proof netting. The monkeys were in intimate contact, and the boxes were frequently changed, the healthy monkey being allowed to live for a few days at a time in the box previously occupied by the infected monkeys. In this experiment the infection might have been carried by skin, urine, or ecto-parasites.

In the second experiment the healthy and the infected monkeys were placed in a small cage covered with coarse wire and divided into two compartments by netting with very large meshes; the netting was fastened to a wooden ledge so arranged that fluid could not pass from one cage to the other. The compartments were of such a shape that when the monkeys were sitting in the cage back to back the skins were in intimate contact, and the monkeys could not turn round. As an additional precaution the arms, legs, and buttocks were placed in mackintosh bags. Infection under these conditions might be carried by both skin and ecto-parasites.

In the third experiment a small mosquito-proof hut was divided into two compartments by fine wire netting fastened below to a board fixed to the terrace by cement. The conveyance of infection by urine, skin, and mosquitos was thus excluded, and only ecto-parasites, which would easily pass through the wire netting, could have operated in conveying the *Micrococcus melitensis* to the healthy animal.

The details of the experiments are as follows:—

Experiment I.—Monkey No. 91 and Monkey No. 95 were inoculated with the *Micrococcus melitensis*, subcutaneously, to act as infecting agents. Monkey No. 91 suffered from a long wave of fever, its temperature rose to 105° on May 29, and remained so with a few intermissions until June 19, when it slowly fell to normal. Its blood

serum diluted 1/500 caused immediate agglutination of the *Micrococcus melitensis.* Monkey No. 95 had a wave of fever lasting from June 20 to June 27, and the blood serum diluted 1/100 reacted with the *Micrococcus melitensis.* The monkey died on July 21, and the specific microbe was recovered from the spleen, bile, mesenteric, femoral and axillary glands.

A wooden framework, covered with mosquito-proof netting, having been erected on the terrace of the Public Health Department, three boxes were placed inside it. On May 25 Monkey No. 92 and Monkey No. 91 were placed in contiguous boxes. The blood serum of No. 92 was examined, but no reaction was obtained.

June 13. Blood of Monkey No. 92 was examined, but no reaction was obtained.

June 14. Monkey No. 92 was found occupying the box of Monkey No. 91.

June 19. The blood of Monkey No. 92 was examined, but without any reaction.

June 24. The blood of Monkey No. 92 was again examined, with a similar result. Monkey No. 95 was put in a box, and the box of Monkey No. 92 was placed between those of Monkeys Nos. 91 and 95.

July 2, July 9, July 16, July 23, and August 9. The blood of Monkey No. 92 was examined, but no reaction appeared.

August 20. The blood serum of Monkey No. 92, diluted 1/10, was found to agglutinate the *Micrococcus melitensis* at once, the reaction being visible to the naked eye.

August 25. Two cubic centimetres of blood were removed from a saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth was obtained.

August 31. The blood serum, diluted 1/100, caused immediate clumping of the *Micrococcus melitensis.*

September 11. One cubic centimetre of blood was removed from a saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth was obtained.

September 13. The blood reaction was found, as recorded, on August 31.

October 4. The monkey was killed with chloroform. At the *post-mortem* examination the body appeared fairly nourished, and the spleen and glands were not enlarged. Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, femoral, and axillary glands. The *Micrococcus melitensis* was recovered from the glands, but the cultures made from the other organs appeared sterile.

Remarks.—The monkey had no rise of temperature during the experiment, and save for a slight loss of flesh appeared perfectly well. The boxes of the monkeys and the floor of the enclosure were

cleansed as little as possible, so as to permit of the infection by urine as well as by the skin and by ecto-parasites. The presence of the *Micrococcus melitensis* in the glands showed that an infection had taken place, and that it was produced by the urine is proved by the results of Experiments II and III.

Experiment II.—A small narrow box covered at the sides with fine wire netting, and having a wooden bottom, was divided into two compartments, each just large enough to hold a monkey in the sitting position, by means of very coarse wire netting. A movable wire floor was sloped from the centre to the sides of each compartment, so that any fluid deposited on it would run off through the wire meshes into the space beneath. By this arrangement the possibility of urine passing from one cage to the other was completely obviated.

Monkey No. 91 was used as the infecting agent, and Monkey No. 88 as the contact.

Monkey No. 88 was kept under observation for 14 days, and its blood repeatedly examined before the experiment was commenced.

On June 8 the monkeys were placed in the cage back to back. The open wire netting of the partition permitted the backs to be in intimate contact, and was merely used to steady the monkeys and prevent them turning round. The arms and legs and buttocks of each monkey were placed in waterproof bags so as to prevent dried urine being conveyed by the infected to the healthy monkey, should the former by any chance manage to turn round in the cage and pass its paws through the loose meshes of the partition. As soon as the monkeys were placed *in situ* the whole cage was covered with mosquito netting.

From June 8 to June 23 Monkey No. 91 and Monkey No. 88 were placed in contact daily for four hours. From June 24 to July 4 Monkey No. 95 was used as the infecting agent. The blood of Monkey No. 88 was examined on June 13, June 18, June 24, and July 2, but no signs of a reaction with *Micrococcus melitensis* were ever seen.

On July 5 Monkey No. 88 was seized with an acute attack of diarrhœa, and he died on July 12.

At the *post-mortem* examination all the organs appeared healthy. Cultures were made from the organs in the usual manner, but all proved sterile.

Remarks.—Infection by urine being excluded, this experiment seems to show that neither ecto-parasites nor intimate skin contact participate in the conveyance of infection from diseased to healthy monkeys.

Experiment III.—The object of this experiment was to ascertain whether ecto-parasites alone could convey infection from a diseased to a healthy monkey.

A small mosquito-proof hut, erected on the terrace of the Public Health Department, was divided into two compartments by strong wire netting, having a meshwork so fine that only small ecto-parasites such as fleas and bugs could pass through it. The wire netting was fastened below to a deal board a foot high and fixed by cement to the floor of the hut.

Monkeys Nos. 110, 92, and 101 were used as the infecting agents. Monkey No. 23, the healthy animal, was kept under observation for a fortnight before the experiment was commenced. Its blood was repeatedly tested, but no reaction with the *Micrococcus melitensis* was observed.

On September 5 Monkey No. 110, which had been injected subcutaneously with the *Micrococcus melitensis* specially for this experiment, was placed in one compartment of the hut, and Monkey No. 23 in the other, the chains of both animals being so arranged that when at full length they could not touch the wire partition. On September 10 Monkey No. 110 showed no sign of fever, and only a very feeble blood reaction. Monkey No. 92 was then placed in its compartment, to act as the infecting agent. On October 5 Monkey No. 92 was removed, and Monkey No. 101, then at the height of a wave of fever, was placed in the infected compartment. The blood of Monkey No. 23 was examined on September 14, 20, and 27, and on October 13 no signs of a reaction with *Micrococcus melitensis* could be detected.

The experiment was continued until November 12, Monkey No. 101 passing through a secondary wave of fever. The blood of Monkey No. 23 was repeatedly examined during November, but no signs of a reaction were observed. The monkey is still alive and well.

Remarks.—Ecto-parasites alone do not appear able to convey infection from a diseased to a healthy monkey.

As the experiments had failed to show that ecto-parasites and direct skin contact play any part in the infection of healthy monkeys living in intimate contact with diseased monkeys, and that the infection was probably caused by the absorption of urine containing the *Micrococcus melitensis*, it appeared desirable to ascertain by direct experiment whether a monkey could be infected by feeding with the urine excreted by Mediterranean Fever patients. Accordingly Monkey No. 119 was fed on urine added to dust and potato, etc.; the details of the experiment were as follows:—

Experiment IV.—Monkey No. 119 was kept under observation in a mosquito-proof chamber for several days before the experiment was commenced. On August 1 the blood was examined, but the serum gave no reaction. The monkey was then fed on fine sterilised dust moistened with urine from a case of Mediterranean Fever containing large numbers of the *Micrococcus melitensis*. The urine dust, thoroughly mixed with potato, was on this occasion readily eaten. On August 2,

3, and 4 the feeding was continued, but it was noticed that after the first feeding the monkey ate very little of the infected potato. On August 7, 8, and 9 attempts were made to get the monkey to drink the urine in its natural state, but with poor success. On August 10 a few cubic centimetres of urine were rubbed up with a considerable quantity of boiled potato, and, as the monkey ate the mixture readily, this method of feeding was continued daily until the 19th, after which date it was fed every other day until the 29th.

The blood was examined on August 11 and 12, but the serum gave no reaction. On August 28, however, slight clumping of the *Micrococcus melitensis* was caused by the serum, diluted 1/10. On August 30 the reaction was quite distinct, the serum being diluted 1/10. On September 5 the blood serum, diluted 1/100, caused instantaneous clumping of the *Micrococcus melitensis*. On September 15 the monkey was killed with chloroform.

At the *post-mortem* examination the spleen was found large, soft, and friable. The axillary, femoral, and mesenteric glands were also found enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, axillary, femoral, and mesenteric glands. The *Micrococcus melitensis* was recovered from the axillary, femoral, and mesenteric glands, the plates being crowded with colonies. It was also isolated from the spleen, but only a few colonies were found on the agar slopes. The remaining cultures proved sterile.

Remarks.—The monkey became infected about 28 days after the feeding was commenced. There was no rise of temperature during the experiment.

Summary.

1. So far as the experiments go it appears that infection cannot be conveyed from infected to healthy monkeys by skin contact alone, all other sources of infection being excluded.

2. That infection cannot be conveyed from infected to healthy monkeys by ecto-parasites alone.

3. That when healthy monkeys living in intimate contact with diseased monkeys, under mosquito-proof conditions, become infected, the infection is due to the absorption of the *Micrococcus melitensis* excreted in the urine of the diseased monkeys.

VI. GOATS AS A MEANS OF PROPAGATION OF MEDITERRANEAN FEVER.

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(Plate 1.)

In Part III of the Reports of the Commission a preliminary note was published on this subject, in which it was shown that goats in Malta suffer from Mediterranean Fever, and excrete the *Micrococcus melitensis* in their milk and urine. The further study of this subject may be divided into the following parts:—

I. Examination of goats living in pens (*a*) in the immediate neighbourhood of Valletta and Sliema, and (*b*) in the more remote parts of the Island.

II. Experiments made to determine the possibility of infecting animals by feeding them on milk-cultures and infected milk.

III. Experiments to determine the mode in which the goats themselves become infected.

IV. Experiments to determine whether it is possible to destroy the *Micrococcus melitensis* by Pasteurisation of the infected milk.

I. Examination of Goats Living in Pens (*a*) in the Immediate Neighbourhood of Valletta and Sliema, and (*b*) in the More Remote Parts of the Island.

(*a*) *Examination of Goats Supplying Milk to Forrest Hospital.*

This herd consisted of 15 goats, and five reacted to the *Micrococcus melitensis.* The serum of Goat No. 37 reacted in a dilution of 1/60, but the sera of Goats Nos. 38, 39, 43, and 48 only reacted in a dilution of 1/20.

Goat No. 37.—This goat was in good health, and its udders were full of milk. On July 4, 5, and 6 the plates made with the deposit from 2 c.c. of the milk were found densely crowded with small colonies of the *Micrococcus melitensis.* The milk was again examined on August 12, September 6, and October 8, and on each of these occasions the plates were found densely crowded with colonies of the microbe. The physical characters of the milk appeared perfectly normal at each examination.

Goat No. 38.—The milk from this goat was centrifugalised, and the deposit plated on July 4, 5, 6, 7, 8, 10, 14, 17, 18, 25, August 19, September 6, and October 8. The *Micrococcus melitensis* was never recovered.

Goat No. 48.—The milk from this goat was examined on the same dates as No. 38. The *Micrococcus melitensis* was not isolated.

Goat No. 43.—The milk from this goat was also examined on the same dates as No. 38. The *Micrococcus melitensis* was not recovered.

Remarks.—The examination of Goat No. 37 shows that the *Micrococcus melitensis* may be excreted steadily in milk for three months without any change occurring in its physical characters. It was thought that Goats Nos. 38, 43, and 48 might be in an earlier stage of the disease than No. 37, and that if they were kept under observation the *Micrococcus melitensis* might eventually appear in the milk. Though the goats were kept under examination for three months, the specific *Micrococcus melitensis* was never recovered from the milk.

Examination of a Small Herd Supplying Milk to Valletta Hospital.

This herd consisted of 13 goats, and four reacted to the *Micrococcus melitensis.*

Goat No. 30.—The serum of this goat reacted only in a dilution of 1/20. The microbe was recovered from the milk from July 1 to July 6, but after this it disappeared.

Goats Nos. 27 *and* 32.—The milk from these goats was examined during June, July, August, and September, but no signs of the *Micrococcus melitensis* were detected. The serum of Goat No. 27 reacted in a dilution of 1/100, and that of No. 32 in a dilution of 1/60.

Remarks.—The *Micrococcus melitensis* was not isolated from the milk of the two goats which judged by the serum reaction would have been considered the most severely infected. In the case of Goat No. 30 the excretion of the parasite continued only for one week, though the secretion of the milk was maintained in good quantity and quality for three months.

Examination of a Small Herd Supplying Milk to Valletta.

This herd consisted of 25 goats, and 17 showed a blood reaction.

Goat No. 50.—Plates made from the milk of this animal were found densely crowded with colonies of the *Micrococcus melitensis.*

Goat No. 52.—During the first week of July the milk of this goat was found to be markedly infected, but examinations made in August, September, and October failed to show any signs of the *Micrococcus melitensis,* though the quantity and quality of the milk continued good.

Goat No. 68.—The milk of this goat contained a comparatively small quantity of the *Micrococcus melitensis*, only 100 colonies being found in the plates made with the deposit from 1 c.c.

Remarks.—The severity of the infection of these goats, judged by the serum reaction, should have been the same, and as the animals were in full milk, the excretion of the microbe might have been expected to occur to the same extent in all the animals. Such was

not the case, and judged by the excretion in the milk it appeared that Goat No. 68 was only infected to a small extent.

Examination of a Small Herd Supplying Milk to Sliema.

Two goats were bought from this herd and placed in the Lazaretto.

Goat No. 15.—The milk of this animal contained large quantities of the *Micrococcus melitensis* during the first week of July, but examinations made in August, September, and October failed to demonstrate the presence of the specific *Micrococcus melitensis.* The quantity and quality of the milk, however, continued good.

Goat No. 16.—The milk of this goat was examined during July, August, September, and October, but no signs of *Micrococcus melitensis* were detected. The blood serum, diluted 1/60, caused immediate agglutination of the microbe when the animal was bought in July, and examinations made at later dates showed that the blood reaction was unchanged.

Remarks.—It appears from the results obtained in the case of Goat No. 16 that an animal may have a marked blood reaction lasting for four months, and yet never excrete the *Micrococcus melitensis* in its milk.

Examination of Goats at Hamrun.

These goats supply a large portion of the milk consumed in Valletta.

The following herds were examined:—

Herd No. 1.—This consisted of 46 goats, and 26 reacted to the *Micrococcus melitensis, i.e.*, 6 in a dilution of 1/100, 4 in a dilution of 1/60, 2 in a dilution of 1/40, 9 in a dilution of 1/20, and 5 in a dilution of 1/10. Only one of these goats showed an excretion of *Micrococcus melitensis* in the milk, and the blood serum reacted in a dilution of 1/100.

Herd No. 2.—There were 30 goats in this herd; the *Micrococcus melitensis* was only found in the milk of one goat. The blood could not be examined, as the owner of the goats refused to allow a specimen to be taken.

Herd No. 3.—There were 26 goats in this herd. The *Micrococcus melitensis* was not isolated from the milk of any of them.

Herd No. 4.—There were 45 goats in this herd. All proved to be quite healthy. No signs of the *Micrococcus melitensis* could be discovered in the milk.

Herd No. 5.—This herd consisted of 32 goats. The milk from five of them was found to contain the *Micrococcus melitensis* in large quantity.

Remarks.—Only 3·3 per cent. of the goats examined contained the *Micrococcus melitensis* in the milk.

Examination of Goats at Pieta.

These goats supplied milk to Valletta; there were 32 animals in the herd and 24 reacted to the *Micrococcus melitensis*, *i.e.*, 13 in a dilution of 1/100, 1 in a dilution of 1/60, 2 in a dilution of 1/40, 4 in a dilution of 1/20 and 4 in a dilution of 1/10. The large number of goats with a high serum reaction was remarkable. Only six goats were found excreting the *Micrococcus melitensis* in the milk, and the sera of all of these reacted in a dilution of 1/100.

Remarks.—About 18·7 per cent. of the goats in this herd were found excreting the *Micrococcus melitensis* in the milk.

Examination of Goats at Paolo.

These goats supplied milk to Paolo and parts of Cospicua and Senglea. There were 24 goats in the herd, and 17 reacted to the *Micrococcus melitensis*. Only three goats were found excreting the microbe in the milk; the blood of two of the goats reacted in a dilution of 1/100 and the third in a dilution of 1/60. Three goats having a blood reaction of 1/100 showed no signs of the microbe in the milk.

Remarks.—About 12·5 per cent. of the goats in this herd were found excreting the *Micrococcus melitensis* in the milk, though judged by the blood reaction some 70 per cent. were infected.

Examination of Goats at Attard.

There were 19 goats in this herd which supplied milk to Attard. None of the goats reacted to the *Micrococcus melitensis*, and the milk of all of them was quite free from infection.

Examination of Goats at Citta Vecchia.

These goats supplied the Military Hospital; there were 15 animals in the herd, and 11 were found to react with the *Micrococcus melitensis*. The milk of five goats was found to contain the specific *Micrococcus melitensis*, and of these the blood sera of three reacted in a dilution of 1/100, the serum of the fourth in a dilution of 1/60, and the serum of the fifth in a dilution of 1/40.

Remarks.—About 33 per cent. of the goats supplying the Military Hospital were found excreting the *Micrococcus melitensis* in the milk.

Examination of Goats at Zeitung.

These goats supplied the three cities. There were 93 animals in three herds. The milk of only one goat was found to contain the *Micrococcus melitensis*.

Milk from a goat in a herd at Zabbar. 10 c.c. centrifugalised and three drops of the deposit spread on a glucose-nutrose-litmus-agar plate. Incubated 4 days at 37° C.

From photo. by Staff-Sergeant Rossiter, R.A.M.C.

Examination of Goats at Zabbar. (Plate 1.)

Four herds were examined. There were 44 goats in the first herd, and the *Micrococcus melitensis* was found in the milk of four of them. In the second herd, containing 28 goats, no signs of the microbe could be found in the milk of any of the animals. In the third herd there were 41 goats; the *Micrococcus melitensis* was found in the milk of only one animal. In the fourth herd, consisting of 19 goats, the milk of one was found to contain the *Micrococcus melitensis.*

Remarks.—About 4·5 per cent. of the goats were found excreting the *Micrococcus melitensis* in the milk.

Examination of Selected Goats at Balzan.

The goats were first subjected to the milk test, and 21 of them showed a tendency to agglutinate the *Micrococcus melitensis.* The milk from these animals was carefully "plated," but the microbe was only recovered from the milk of six of them.

Remarks.—About 29 per cent. of the goats selected by the milk agglutination test were found excreting the *Micrococcus melitensis* in the milk.

Examination of Selected Goats at Casal Lia.

These goats were also subjected to the milk test, and 13 appeared to be infected. The *Micrococcus melitensis*, however, was only found in the milk of four of them.

Remarks.—About 30 per cent. of the selected goats were found excreting the *Micrococcus melitensis* in the milk. The percentage was practically the same as that obtained in the case of the goats selected at Balzan.

Examination of Selected Goats at Zabbar.

Five appeared to be infected, judged by the milk test, and the *Micrococcus melitensis* was found in the milk of two of them.

Remarks.—About 40 per cent. of the selected goats appeared to contain the *Micrococcus melitensis* in the milk, but the figures are too small to be of any practical value.

Examination of Goats at Melleha.

There were 91 goats in the herds, and 16 showed a reaction with the *Micrococcus melitensis*; the specific microbe was not found in the milk of any of them.

Examination of Goats at the Lunatic Asylum.

There were 31 goats in this herd, which was kept in the Asylum grounds. The goats were not allowed to graze in the public streets. A careful examination of the milk, by means of the agglutination test,

was made, but no reaction was obtained. Ten cubic centimetres of milk from each animal was then centrifugalised and the deposit "plated;" no signs of the *Micrococcus melitensis* were observed in any of the plates.

The following table gives the degree of reaction obtained in each of the infected goats, worked out to a dilution of 1/100.

Each goat is designated by a number, which is placed in the column corresponding to the highest dilution in which its blood reacted:—

	Dilutions.						
	1/10.	1/20.	1/40.	1/60.	1/80.	1/100.	Total.
Herd I	2 80	74 78	1 75			83	7
" II						5	1
" III							0
" IV		22 30		32		27	4
" V		38 39 43 48		37			5
" VI	51 59 62 63 65 73	54 66 67 70		64		50 52 55 60 68 71	17
" VII	97 109 117 120 123	88 93 96 106 110 112 113 125 128	85 90	103 111 119 126		99 102 105 121 122 129	26
" VIII	137 140 144 148	134 135 141 149	131 157	147		132 133 136 138 145 151 153 154 155 156 152 160 161	21

	Dilutions.						
	1/10.	1/20.	1/40.	1/60.	1/80.	1/100.	Total.
Herd IX	167 169 185 200 208 215 232 234 242 247	166 174 202 231	163	191			22
" X	253 255						2
" XI	281	283	268 273 277 282	261 266 271 274 279	278	260 263 264 270 280	17
" XII	288 294					302	3
" XIII	307 316	313 318	311	310	326	309 314 315 321	11
" XIV	3	7 8 9				1	5
Total number of goats	35	35	12	15	2	39	138

Blood Examination of Goats from various parts of Malta.

Herds and number of goats.	Address.	Supply milk to	Total number tested.	Number which gave a definite blood reaction.	Percentage of reactions.
I Nos. 1 to 4 and 74 to 83	Casal Tarshiel, near Casal Paolo	Cottonera Hospital, Zabbar Gate, and near-lying part of town	14	7	50·0
II Nos. 5 to 17	Zabbar	,, ,,	13	1	7·69
III Nos. 18 to 20	Hamrum	Valletta	3	0	0·0
IV Nos. 21 to 33	Casal Curmi	Valletta Hospital and town	13	4	30·6
V Nos. 34 to 48	St. George's Bay	Forrest Hospital.	15	5	33·3
VI Nos. 49 to 73	St. John's Ditch	Valletta	25	17	68·0
VII Nos. 84 to 129	Hamrun	,, ...	46	26	56·5
VIII Nos. 130 to 161	Pieta	,, ...	32	24	75·0
IX Nos. 162 to 252	Melleiha village	Melleiha Camp, Ghain Tuffeiha, Melleiha village, and 1 mile radius	91	16	17·6
X Nos. 253 to 259	Birchircara	Birchircara village	7	2	28·5
XI Nos. 260 to 283	Paolo	Paola and near-lying parts of Cospicua and Senglea	24	17	70·8
XII Nos. 284 to 306	Ghashak............	Cospicua, Senglea, and Cottonera	23	3	13·0
XIII Nos. 307 to 330	Citta Vecchia ...	Hospital............	15	11	73·3
XIV Private herd Nos. 1 to 10	Sliema	A few private houses, Sliema	10	5	50·0

Total number of goats examined 331
Number which gave a reaction 138
Percentage of goats found infected = 41·69

Examination of Goats' Milk for Agglutinative Reaction to Micrococcus melitensis (*Zammit's Test*).

Two methods were tried :—

1. Sedimentation in Tubes.—The milk was diluted with four times the amount of emulsion of *Micrococcus melitensis* and left standing for 12 hours in sedimentation tubes. This method was found to be unreliable, as the sediment often consisted of fat and *débris*, and always required to be submitted to microscopic examination.

2. Agglutination under the Microscope.—Equal parts of milk and emulsion were placed on a slide and allowed to stand for 12 hours in a moist chamber. At the end of this time the fatty part of the milk had collected in the centre and the surface of the drop, leaving the edges and the bottom clear. The clear part was then examined under 1/6 inch lens for clumping of *Micrococcus melitensis*. It should be noted that the milk was prevented from turning sour by adding one drop of 40 per cent. of formalin to 10 c.c. of milk.

The second method was found much the more certain, and, after a trial of 57 samples of milk examined in both ways, was adopted in preference to the first. Samples of the milk of 57 goats whose blood had been tested were examined in both these ways. The examination of the blood showed a positive agglutinative reaction to *Micrococcus melitensis* in 41. The milk gave a positive reaction—(1) by sedimentation in 17, (2) by microscope in 27.

In all, the reaction of 115 samples of milk was examined, and a positive reaction was obtained in 47. All these samples were more or less selected, and cannot be taken as a fair average; of these, 86 were examined for serum reaction, with the following result :—

Blood positive, milk positive	42	= 48·8 per cent.
Blood positive, milk negative	16	= 18·6 ,,
Blood negative, milk negative......	28	
	86	

∴ Milk gave a reaction in only 72·4 per cent. of those giving a serum reaction.

The numbers of the 16 goats (blood positive and milk negative) mentioned above are as follows :—

No. of goat.	Reaction of blood in dilutions.	Whether *Micrococcus melitensis* was found in milk?
43	1/10	No.
48	1/20	„
112	1/20	„
119	1/40	„
140	1/10	„
163	1/40	„
174	1/10	„
215	1/10	„
232	1/10	„
281	1/10	„
282	1/40	„
288	1/10	Not examined.
302	1/100	—
313	1/10	No.
316	1/10	„
318	1/20	„

Remarks on the goats whose blood was examined for reaction to Malta Fever.

It was expected that those goats whose blood reacted would have some symptoms of illness, but this was not apparent except in a few instances. A few goats were noticed to have an unusual degree of lassitude and to be off food. In the later stages of the infection, when the milk was beginning to dry up, a short, hacking cough was noticed, and the goats appeared to steadily lose flesh, the coat also became thin. The quantity and quality of the milk seemed in most cases to be unaffected, indeed it was remarked how often the best milkers in the herd were picked out as a result of the blood examination.

The following goats reacted in a dilution of 1/100, and their daily milk production was as follows :—

No. of goat.	Quantity of milk in pints.
132	3
133	3
136	5
138	2
151	6
153	2
154	6
156	4
159	2
160	2½

A good average milk production is from four to five pints a day, so it appears that when the blood reaction is very marked there may be a diminution in the quantity, though the physical characters and chemical composition of the milk remain unchanged.

Pregnancy goes on uninterruptedly in infected goats; a miscarriage was reported only in one instance.

The Relation of the Blood and Milk Agglutination to the Infection of the Milk.

As a rule, if the blood agglutination was over 40 dilutions, the milk reaction was present in 85 per cent.

If the blood agglutination reached only 20 dilutions, the milk reaction was present in 60 per cent., and in 10 dilutions only 30 per cent.

The following are the numbers of some goats where the reaction in the blood did not go beyond a dilution of 1/10, yet the milk reaction was present:—

307, 148, 137, 39, 38, 185.

It is thrown out as a suggestion that the presence of the reaction in the milk may be a better guide to the presence of *Micrococcus melitensis* in the milk than the examination of the blood, especially when a good case can be brought forward, such as Goat No. 4 (Lazaretto).

In this case the milk reaction was present, though the blood reaction was only 1/10, and at the same time *Micrococcus melitensis* was being excreted in the milk in very considerable quantities. However, as the excretion of *Micrococcus melitensis* continued in the milk, the blood agglutination crept up until it reached 1/40.

II. To Test the Virulence of the *Micrococcus melitensis* Excreted in Goats' Milk, and the Possibility of Infecting Animals by Feeding with Milk Cultures and Infected Milk.

(A) *To Test the Virulence of* Micrococcus melitensis *Isolated from Goats' Milk.*

Monkey No. 107 was brought from Calcutta and placed on the terrace of the Public Health Department:—

1905—

July 18. Examined blood; no reaction obtained.

,, 19. Injected subcutaneously, growth on an agar slope, isolated from the milk of infected goat No. 5.

,, 25. Examined blood; dilution 1/10 reacted at once, visible to naked eye.

,, 30. Examined blood; dilution 1/10 reacted at once, dilution 1/20 reaction not complete.

1905—

July 31. Drew off 2 c.c. of blood from saphenous vein and planted out in broth.

Aug. 7. Planted out growth in broth on an agar slope, typical growth of *Micrococcus melitensis* resulted.

„ 20. Examined blood; dilution 1/50 reacted, but clumping not quite complete.

Sept. 2. Removed 1·5 c.c. of blood from saphenous vein; after seven days' incubation at 30° C. no growth resulted.

„ 3. Examined blood; dilution 1/100 reacted at once.

„ 13. Examined blood; reaction as on the 3rd.

„ 20. Monkey ill and steadily losing flesh.

„ 26. Monkey dying. Killed with chloroform.

Post-mortem Examination.—Body much emaciated; lymphatic glands not appreciably enlarged; spleen very small; liver mottled.

Cultures were made from spleen, liver, kidneys, heart's blood, bile, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from the mesenteric glands, all the other organs remained sterile.

(B) *To Determine the Possibility of Infecting Monkeys and Goats by Feeding with Cultures of* Micrococcus melitensis *Isolated from Milk.*

Experiment I.—Monkey No. 6 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto:—

1905—

July 30. Examined blood; no reaction obtained.

Aug. 1. Fed on *Micrococcus melitensis* isolated from milk of Goat No. 99, growth on an agar slope being made into a paste with potato.

„ 5. Fed as on the 1st, culture of *Micrococcus melitensis* isolated from milk of Goat No. 17 being used.

„ 8. Fed as on the 5th.

„ 9. Fed as on the 5th; culture isolated from milk of Goat No. 15 used.

„ 10. Examined blood; no reaction obtained.

„ 12. Fed as on the 9th.

„ 17. Fed as before; culture isolated from milk of Goat No. 5 used.

„ 21. Examined blood; no reaction obtained.

„ 22. Fed as on the 17th.

„ 24. Fed as on the 5th.

„ 25. Examined blood; no reaction obtained.

Sept. 1. Examined blood; serum, diluted 1/10, reacted at once, clumps visible with naked eye.

1905—

Sept. 4. Removed 2 c.c. of blood from saphenous vein and planted out in broth tubes. After seven days' incubation at 37° C., no growth obtained.

„ 5. Examined blood; serum, diluted 1/100, reacted at once.

„ 6. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen slightly enlarged; liver congested; femoral and axillary glands markedly enlarged; mesenteric glands slightly enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from all the cultures except those made with the bile.

The agar slopes inoculated with the spleen, and the plates, over which sections of the glands had been rubbed, were densely crowded with colonies.

Remarks.—The monkey never suffered from fever, and gained in weight during the experiment. The animal was killed five days after the blood reacted, in the hope of ascertaining whether the mesenteric glands were infected earlier and to a greater extent than the axillary and femoral glands. No difference, however, could be ascertained between the glands; all the organs appeared to be teeming with the *Micrococcus melitensis.* The intestines were carefully examined, and no signs of any abrasion or inflammation in the mucous membrane could be detected. This experiment proves that the *Micrococcus melitensis* can be absorbed through a healthy mucous membrane, and shows that the organs may be extensively infiltrated with the *Micrococcus melitensis* without apparently producing any prejudicial effect on the health of the animal during the first week after absorption.

Experiment II.—Monkey No. 7 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—

July 30. Examined blood; no reaction obtained.

Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from infected Goat No. 154.

„ 5. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from infected Goat No. 30.

„ 8. Fed as on the 5th.

„ 9. Fed as on the 5th.

„ 10. Fed as on the 5th. Examined blood; no reaction obtained.

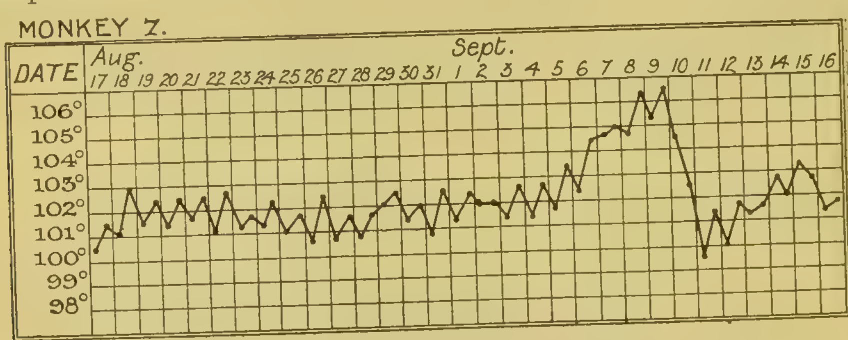
„ 12. Fed as on the 5th, but culture isolated from Goat No. 17 used.

„ 17. Fed as before, agar culture isolated from Goat No. 5 used.

1905—
Aug. 22. Fed as on the 17th.
" 24. Fed as on the 17th, agar culture isolated from Goat No. 60 used.
" 25. Examined blood; no reaction obtained.
Sept. 1. Examined blood; no reaction obtained.
" 5. Examined blood; serum, diluted 1/50, reacted at once.
" 10. Removed 1 c.c. of blood from saphenous vein and planted in broth-tubes; after seven days' incubation at 37° C. no growth obtained.
" 11. Examined blood; serum, diluted 1/100, reacted at once.
" 15. Removed 2 c.c. of blood from saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C. no growth obtained.
" 20. Examined blood; serum, diluted 1/1000, reacted at once.
" 24. Killed monkey with chloroform.

Post-mortem Examination.—Body well nourished; femoral and axillary glands enlarged, mesenteric glands not enlarged; spleen enlarged, soft and friable; liver very congested. Cultures were made from the spleen, liver, kidneys, heart's blood, bile, mesenteric, axillary, and femoral glands. The *Micrococcus melitensis* was recovered from the mesenteric, femoral, and axillary glands, the heart's blood, and spleen. The plates inoculated with sections of the glands were densely crowded with colonies, but though 12 agar slopes were inoculated with sections of the spleen, only a few colonies were found on four of them.

The following chart shows the temperature of the monkey during the experiment.



Remarks.—This monkey suffered from a typical wave of fever like Monkey No. 5, fed on infected goat's milk. The distribution of the *Micrococcus melitensis* was very similar in the two monkeys. The interval between the commencement of feeding and the first sign of infection was longer in Monkey No. 7, though it received very much larger doses of the *Micrococcus melitensis.*

Experiment III.—Monkey No. 8 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—

July 30. Examined blood; no reaction obtained.

Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis*, isolated from Goat No. 50.

" 8, 10, 12 and 18. Fed as on the 1st.

" 22. Fed on agar culture, isolated from Goat No. 261.

" 24. Fed on agar culture, isolated from Goat No. 138.

" 10. Examined blood; no reaction obtained.

" 17. Examined blood; no reaction obtained.

" 25. Examined blood; slight tendency to a reaction observed.

Sept. 1. Examined blood; serum, diluted 1/10, reacted at once.

" 7. Examined blood; serum, diluted 1/500, gave an immediate reaction.

" 8. Removed 2 c.c. of blood from saphenous vein and planted out in broth-tubes; after seven days' incubation at 37° C., no growth obtained.

" 14. Removed 2 c.c. of blood and treated as on the 8th, no growth of *Micrococcus melitensis* observed.

" 29. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen large and soft; liver and kidneys congested; mesenteric, axillary and femoral glands enlarged.

Cultures were made from the spleen, liver, kidneys, bile, heart's blood, mesenteric, axillary, and femoral glands. A few colonies of the *Micrococcus melitensis* were found in the plates made from the mesenteric, axillary, and femoral glands. All the other cultures proved to be sterile.

Remarks.—This monkey never suffered from fever and put on weight during the experiment.

Experiment IV.—Monkey No. 9, brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto.

1905—

July 30. Examined blood; no reaction obtained.

Aug. 1. Fed on potato mixed with an agar culture of *Micrococcus melitensis* isolated from Goat No. 105.

" 5, 8, 9, and 10. Fed as on the 1st.

" 12. Fed on agar culture isolated from Goat No. 7.

" 17. Fed on agar culture isolated from Goat No. 15.

" 22. Fed on agar culture isolated from Goat No. 309.

" 24. Fed on agar culture isolated from Goat No. 261.

" 10 and 17. Blood examined; no reaction obtained.

" 25. Examined blood; distinct reaction after standing for 24 hours.

Sept. 1. Examined blood; serum diluted 1/10; reacted at once.

1905—

Sept. 7. Removed 2 c.c. of blood from saphenous vein, and planted out in broth-tubes; after seven days' incubation at 37° C. a growth of *Micrococcus melitensis* appeared, which gave all the characteristic tests. Examined blood; serum, diluted 1/1000, gave an immediate reaction.

„ 29. Suffering from fever and losing flesh.

Oct. 2. Very ill, fever still present.

„ 5. Monkey died this morning.

Post-mortem Examination.—Fairly nourished; spleen enlarged; liver congested; mesenteric glands not much enlarged, but congested. A little peritonitis present around the colon.

Cultures were made from the spleen, liver, kidneys, heart's blood, bile, mesenteric, femoral, and axillary glands.

The *Micrococcus melitensis* was recovered from the femoral and axillary glands.

Remarks.—The rise of temperature and subsequent death of this monkey were caused by the peritonitis around the colon. There were no signs of erosion or perforation of the intestine. The peritonitis was probably due to an external injury caused by an iron bracket placed in the wall for the monkey to sit upon.

To Determine the Period of Incubation.

Experiment V.—Monkey No. 19A was placed in a mosquito-proof chamber in the Lazaretto, and kept under observation for a month before the feeding was commenced. Its blood was repeatedly tested, but no reaction was ever obtained. On September 4 it was fed with the growth of an agar slope of *Micrococcus melitensis* isolated from the milk of Goat No. 15. On September 5 the feeding was repeated, but after this date no more culture was given. The blood was examined on September 10, 19, and 23, and on October 5, but no reaction was obtained. On October 7, however, the blood serum, diluted 1/10, caused immediate agglutination of the *Micrococcus melitensis*, the reaction being visible with the naked eye. On October 15 the blood reaction was noticed to be diminishing, as the serum, diluted 1/10, only gave an incomplete reaction with the *Micrococcus melitensis*. On October 16 the monkey was killed with chloroform. At the *post-mortem* examination all the organs appeared healthy. Cultures were made from the spleen, kidneys, liver, bile, heart's blood, and glands. A profuse growth of the *Micrococcus melitensis* was obtained from the spleen and from the femoral and axillary glands. The *Micrococcus melitensis* was also recovered from the heart's blood. The other cultures proved to be sterile.

Remarks.—The monkey never suffered from fever during life, and did not show any signs of ill-health. Although the blood serum had a very feeble agglutinating reaction, the spleen and glands were extensively infiltrated with the *Micrococcus melitensis.*

The period of incubation appeared to be about 32 days.

Feeding Experiment with Milk Cultures.

Goat No. 12 was placed in the Lazaretto and kept under observation for one month before the experiment was commenced.

1905—

June 26. Examined blood; no reaction obtained.

July 30. Examined blood; no reaction obtained.

„ 31. The growth on one agar slope of *Micrococcus melitensis*, isolated from milk of Goat No. 160, emulsified in water and poured down the throat, no gag being used.

Aug. 5. Fed again as on the 31st.

„ 8. Milk withdrawn from udder, 10 c.c. centrifugalised, and deposit plated on surface of glucose-nutrose-agar plates. No signs of *Micrococcus melitensis* detected.

„ 12. Examined blood; no reaction obtained.

„ 25. Fed on one agar slope of *Micrococcus melitensis*, isolated from milk of Goat No. 5.

„ 29. Fed as on the 25th.

„ 30. Examined blood; no reaction obtained.

Sept. 3. Fed as on the 25th.

„ 5. Fed as on the 25th.

„ 6. Examined blood; no reaction obtained.

„ 9. Fed as on the 25th.

„ 11. Examined blood; no reaction obtained.

„ 13. Fed as on the 25th.

„ 20. Examined blood; no reaction obtained.

„ 26. Examined blood; dilution 1/10, reaction at once.

Oct. 1. Drew off milk, centrifugalised 10 c.c. and plated deposit; no signs of *Micrococcus melitensis* detected.

„ 2. Examined blood; dilutions 1/10, 1/20, and 1/50 gave a complete reaction at once.

„ 6. Removed 5 c.c. of blood from jugular vein and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

„ 9. Drew off milk, centrifugalised 10 c.c. and plated deposit; no signs of *Micrococcus melitensis* detected.

„ 16, 23, and 30. Milk examined as on the 9th; *Micrococcus melitensis* not recovered.

The examination of the milk and blood was continued once a week until November 30. The blood still reacted in a dilution of 1/40, but no signs of the excretion of the *Micrococcus melitensis* in the milk appeared. The goat is still under observation.

Remarks.—This experiment shows either that the *Micrococcus melitensis* is not always excreted in the milk of goats having a marked blood reaction, or that the excretion is a very late phenomenon.

Experiments to Determine the Possibility of Infecting Monkeys by Feeding them with Goat's Milk Containing the Micrococcus melitensis.

Experiment I.—Monkey No. 5 was brought from Calcutta and placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—

July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis.*

" 27. Fed once a day on milk derived from a small herd of infected goats. There were 11 goats in the herd and the serum from all of them gave a reaction with the *Micrococcus melitensis.* The *Micrococcus melitensis,* however, was only present in the milk of nine of them. A gag was not used; at first the mouth was opened slightly by pressing externally with the thumb and first finger opposite the last molar teeth, but after a few days the monkey learned to lap up milk like a cat.

July 28 to Aug. 6. Feeding continued once a day.

Aug. 4. Feeding continued. Blood examined, serum gave no reaction with the *Micrococcus melitensis.*

" 5. Feeding continued once a day.

" 6. Milk given three times a day.

" 7. Milk given three times a day. Blood examined and no reaction obtained.

" 8. Milk given three times a day. Blood examined and no reaction obtained.

" 9. Milk given three times a day. Blood examined and no reaction obtained.

" 10 to 14. Feeding continued three times a day.

" 15. Feeding continued. Blood examined; serum showed a slight tendency to react with the *Micrococcus melitensis.*

" 16. Feeding continued. Blood examined: no distinct reaction obtained.

" 17 to 25. Feeding continued. The blood was examined on the 21st and 23rd, but no reaction was obtained.

" 25. Blood examined; complete reaction obtained, serum diluted 1/10. Dilution 1/30 gave no reaction.

1905—

Aug. 27. One cubic centimetre of blood removed from a saphenous vein planted out in broth and incubated at 37° C. Incubation continued for seven days and the broth then planted out on agar slopes. No growth resulted.

Examined blood. Reaction at once, visible to naked eye, serum diluted 1/10. Dilution 1/30 gave a complete reaction after half-an-hour.

„ 28. Removed 1 c.c. of blood from a saphenous vein and treated as on the 27th; no growth resulted.

„ 31. Examined blood; serum diluted 1/100 gave a reaction at once. Dilution 1/200 gave an incomplete reaction after one hour.

Sept. 5. One cubic centimetre of blood removed from a saphenous vein and planted out in broth. After incubation at 37° C. for seven days no growth resulted.

„ 6. Two cubic centimetres of blood removed from a saphenous vein and planted out in broth. After incubation at 37° C. for seven days no growth resulted.

„ 7. Examined blood; serum, diluted 1/100, reacted at once.

„ 11. Examined blood; serum, diluted 1/1000, reacted at once. Killed the monkey with chloroform.

Post-mortem Examination.—Body well nourished; axillary, femoral, and mesenteric glands enlarged; spleen very large and soft and friable in consistence; liver enlarged and congested; kidneys congested; intestines congested in patches. Cultures were made as follows:—

Spleen.—Planted out on agar slopes (12) and in broth tubes.

Liver.—Planted out on agar slopes (12) and in broth tubes.

Kidney.—Planted out on agar slopes (12) and in broth tubes.

Heart's Blood.—Planted out in broth tubes.

Bile.—Planted out on the surface of glucose-nutrose-agar plates.

Urine.—Planted out on the surface of glucose-nutrose-agar plates.

Axillary Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

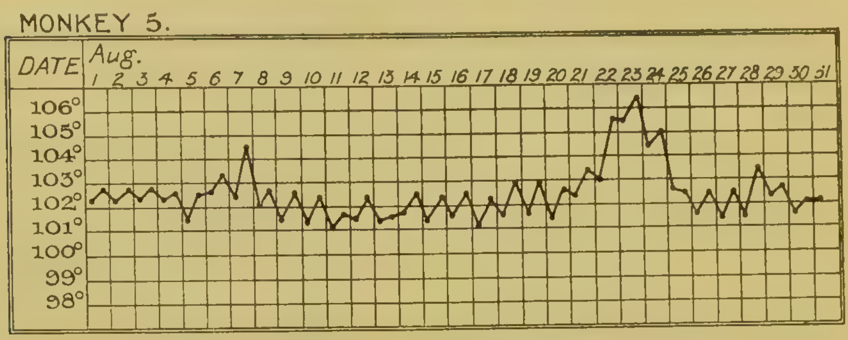
Femoral Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

Mesenteric Glands.—Sections made and the surfaces rubbed over glucose-nutrose-agar plates.

After four days' incubation at 37° C., all the plates made from the glands were found densely crowded with colonies of the *Micrococcus melitensis.* Out of the 12 agar slopes inoculated with the spleen only one showed the microbe, and on this slope only four colonies were counted. The cultures made from the liver, kidney and heart's blood

remained sterile. No sign of the *Micrococcus melitensis* could be detected in the plates made from the bile and urine.

The following temperature chart shows a typical short wave of fever such as is usually seen when a monkey is inoculated with the *Micrococcus melitensis* subcutaneously.



Remarks.—After an interval of about 24 days from the commencement of the feeding the monkey suffered from a typical attack of Mediterranean Fever. The distribution of the *Micrococcus melitensis* in the body was somewhat peculiar, the mesenteric and systemic lymphatic glands being densely crowded with the *Micrococcus melitensis*, while the spleen only showed four colonies.

Experiment II.—Monkey No. 4, brought from Calcutta, was placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—

July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis.*

" 28. Fed on mixed milk obtained from the same goats as were used in Experiment I. The same method of feeding was followed as with Monkey No. 5, and was continued from this date until a distinct blood reaction was obtained.

Aug. 4. Examined blood; no reaction obtained.

" 13. Examined blood; no reaction obtained.

" 16. Examined blood; no reaction obtained.

" 21. Examined blood; no reaction obtained.

" 28. Blood serum, in dilutions of 1/10 and 1/40, gave a complete reaction with the *Micrococcus melitensis*, visible with the naked eye in five minutes.

" 31. Removed 0·5 c.c. of blood from a saphenous vein and planted out in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

Sept. 1. Removed 2 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

1905—

Sept. 3. Blood serum diluted 1/50 gave an immediate reaction.

„ 9. Removed 1 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained. Blood serum, diluted 1/500, gave an immediate reaction with the *Micrococcus melitensis.*

„ 16. Removed 2 c.c. of blood and planted in broth-tubes. After seven days' incubation at 37° C. no growth was obtained.

„ 21. Killed monkey with chloroform.

Post-mortem Examination.—Body well nourished; spleen enlarged, soft and friable in consistence; liver very congested; kidneys congested; axillary and femoral glands enlarged; mesenteric glands not enlarged. Cultures were made as follows:—

Spleen.—Planted out on 12 agar slopes and in broth-tubes.

Liver.—Planted out on 12 agar slopes and in broth-tubes.

Kidney.—Planted out on 12 agar slopes and in broth-tubes.

Heart's Blood.—Planted out in broth.

Bile.—Planted out on the surface of glucose-nutrose-agar plates.

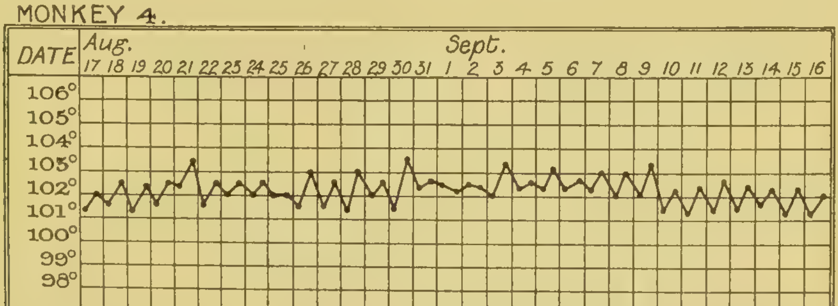
Artillery Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Femoral Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Mesenteric Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

After four days' incubation at 37° C. only 15 colonies were found on the agar slopes inoculated from the spleen. The liver and kidney cultures were sterile, and no signs of the *Micrococcus melitensis* were observed on the plates made from the bile and axillary glands. Numerous colonies, however, were found in the plates made from the femoral and mesenteric glands. The following chart shows the temperature of the monkey during the experiment:—

MONKEY 4.



Remarks.—After an interval of 33 days from the commencement of feeding this monkey became infected, but there was never any wave of fever as in Experiment I. The distribution of the *Micrococcus*

melitensis in the body was similar to that observed in the first experiment.

Experiment III.—Monkey No. 2 was brought from Calcutta, and placed in a mosquito-proof chamber in the Lazaretto, Malta.

1905—

- July 26. Examined blood; serum gave no reaction with the *Micrococcus melitensis.*
- ,, 27. Fed on mixed milk as in Experiments I and II.
- ,, 28 to Aug. 3. Feeding continued.
- Aug. 4. Examined blood; no reaction obtained.
- ,, 4 to 12. Feeding continued.
- ,, 13. Examined blood; no reaction obtained.
- ,, 13 to 23. Feeding continued.
- ,, 24. Examined blood; no reaction obtained.
- ,, 24 to 27. Feeding continued.
- ,, 28. Examined blood; no reaction obtained.
- ,, 28 to Sept. 2. Feeding continued.
- Sept. 3. Examined blood; no reaction obtained.
- ,, 3 to 7. Feeding continued.
- ,, 8. Examined blood; no reaction obtained.
- ,, 8 to 17. Feeding continued.
- ,, 18. Examined blood; no reaction obtained.
- ,, 18 to 23. Feeding continued.
- ,, 24. Examined blood; no reaction obtained.
- ,, 24 to 27. Feeding continued.
- ,, 28. Examined blood; no reaction obtained.
- ,, 28 to Oct. 2. Feeding continued.
- Oct. 3. Examined blood; no reaction obtained.
- ,, 4 to 8. Feeding continued.
- ,, 9. Examined blood; a slight reaction obtained after two hours.

From this date the blood was examined weekly, but a definite reaction was not obtained again. The monkey died suddenly on Oct. 18. At the *post-mortem* examination a localised abscess was found round the sigmoid flexure. The organs appeared healthy. Cultures were made from the spleen, glands, and heart's blood. The *Micrococcus melitensis* was isolated from the spleen and glands.

A specimen of blood obtained at the *post-mortem* was tested for agglutination. A dilution of 1/10 gave an incomplete reaction.

Remarks.—During life the monkey suffered from a wave of fever which was attributed to an infection with the *Micrococcus melitensis*, but the *post-mortem* examination showed that the febrile condition might have been due to the abscess round the sigmoid flexure. Although a specific infection undoubtedly occurred, as shown by the isolation of the *Micrococcus militensis* from the spleen and glands, the blood serum

only once during life caused complete agglutination of the *Micrococcus melitensis*, and that only in a dilution of 1/10.

Experiment IV.—Monkey No. 99 was brought from Calcutta and placed on the terrace of the Public Health Department, Valletta :—

1905—

June 21. Examined blood; no reaction obtained.
„ 26. Examined blood; no reaction obtained. Fed on milk from infected Goat No. 2.
„ 27. Fed on milk from infected Goat No. 2.
July 2. Examined blood; no reaction obtained.
„ 9. Examined blood; no reaction obtained.
„ 16. Examined blood; no reaction obtained.
„ 22. Examined blood; no reaction obtained.
„ 23. Fed on mixed milk obtained from infected herds at Pieta and Hamrun.
„ 24 to 28. Feeding continued.
„ 29 to Aug. 8. Fed on mixed milk obtained from the infected goats in the Lazaretto.
Aug. 6. Examined blood; no reaction obtained.
„ 15. Examined blood; no reaction obtained.
„ 16 to 21. Fed on milk from infected Goat No. 37.
„ 22. Monkey suffering from diarrhœa. Feeding discontinued.
„ 23. Examined blood; no reaction obtained.
„ 24 to 29. Fed on milk from Goat No. 37.
„ 30. Examined blood; slight reaction with serum diluted 1/10.
Sept. 3. Examined blood; distinct reaction after half an hour, serum diluted 1/10.
„ 5. Examined blood; serum diluted 1/100 reacted at once, and diluted 1/300 reacted in half an hour.
„ 9. Removed 2 c.c. of blood from a saphenous vein and planted out in broth-tubes. After seven days' incubation at 37° C. no growth obtained.
„ 17. Removed 2 c.c. of blood and treated as on the 9th; no growth obtained.
„ 25. Killed monkey with chloroform.

Post-mortem Examination.—Fairly nourished; axillary and femoral glands very large, mesenteric glands enlarged; spleen large, soft and friable; liver very congested.

Cultures were made as follows :—

Spleen.—Planted out on agar slopes and in broth-tubes.

Liver.—Planted out on agar slopes and in broth-tubes.

Kidney.—Planted out on agar slopes and in broth-tubes.

Heart's Blood.—Planted out in broth-tubes.

Bile.—Planted out on the surface of the glucose-nutrose-agar plates.

Femoral Glands.—Sections made and then rubbed over glucose-nutrose-agar plates.

Axillary Glands.—Sections made and then rubbed over glocose-nutrose-agar plates.

Mesenteric Glands.—Sections made and then rubbed over glucose-nutrose-agar slopes.

After four days' incubation at 37° C. the *Micrococcus melitensis* was recovered from the plates made from the mesenteric glands.

Remarks.—A blood reaction pointing to the infection was not obtained until about 70 days from the commencement of feeding. The monkey never suffered from fever, but the high dilution in which the blood serum reacted and the presence of the *Micrococcus melitensis* in the mesenteric glands showed that a true infection had taken place.

To Determine the Possibility of Infecting a Goat by Feeding on Infected Milk.

Goat No. 8.—This goat had been in the Lazaretto for two months before the experiment was commenced :—

1905—

June 27. Examined blood ; no reaction obtained.

„ 29. Fed on mixed milk obtained from infected goats in the Lazaretto.

July 1. Fed as on the 29th.

„ 8. Examined blood ; no reaction obtained.

„ 13. Removed 10 c.c. of milk from udder, centrifugalised specimen, and plated deposit on glucose-nutrose-agar plates. No signs of the *Micrococcus melitensis* detected.

„ 28. Examined blood ; no reaction obtained.

„ 29 to August 24. Fed three times a day on mixed milk derived from the infected goats in the Lazaretto.

Aug. 4. Examined blood ; no reaction obtained.

„ 13. Examined blood ; no reaction obtained.

„ 22. Examined blood ; no reaction obtained.

Sept. 26. Examined blood ; no reaction obtained.

Oct. 7. Examined blood ; serum diluted 1/10 gave an incomplete reaction.

„ 9. Examined blood ; serum diluted 1/10 gave an immediate reaction, visible with the naked eye. Removed 5 c.c. of blood from the jugular vein and planted out in broth-tubes ; after seven days' incubation at 37° C. no growth obtained. Drew off 10 c.c. milk, centrifugalised specimen, and planted out deposit on glucose-nutrose-agar plates. No signs of *Micrococcus melitensis* detected.

1905—
Oct. 18. Examined blood; serum diluted 1/10 gave an incomplete reaction.
„ 23. Milk centrifugalised and deposit plated; *Micrococcus melitensis* not recovered.
„ 25. Blood serum diluted 1/10 gave an incomplete reaction.
„ 30. Milk examined as on the 23rd. *Micrococcus melitensis* not recovered.
Nov. 30. The *Micrococcus melitensis* has not yet appeared in the milk. The goat is still under observation.

To Test the Possibility of Infecting a Kid by Feeding on Infected Milk.

Kid No. 9.—This kid was under observation for about two months before this experiment was commenced. The blood was repeatedly examined, but no reaction could be obtained with the *Micrococcus melitensis.* It was placed in a room quite apart from the infected goats :—

1905—
July 13. Examined blood; no reaction obtained. Commenced feeding with milk obtained from infected goats in the Lazaretto.
„ 14 to 27. Fed once a day on the infected milk.
„ 28 to August 28. Fed three times a day on the infected milk.
July 22. Examined blood; no reaction obtained.
„ 30. Examined blood; no reaction obtained.
Aug. 7. Examined blood; no reaction obtained.
„ 13. Examined blood; no reaction obtained.
„ 21. Examined blood; no reaction obtained.
„ 27. Examined blood; no reaction obtained.
Sept. 5. Examined blood; no reaction obtained.
„ 14. Examined blood; no reaction obtained.
„ 26. Examined blood; dilution 1/10 reacted at once, clumps visible with naked eye.
Oct. 8. Examined blood; dilution 1/10 gave an immediate reaction, dilution 1/20 " nil."
„ 31. Killed the kid and made cultures from the spleen, kidneys, liver, glands, and blood from the inferior vena cava. The *Micrococcus melitensis* was not recovered from any of the organs.

Remarks.—Though a blood reaction was obtained, a true infection did not appear to have taken place. Three other kids fed in the same manner are still under observation.

Feeding with Infected Milk and also with Culture Isolated from Spleen of Man.

Goat No. 4.—This goat was kept under observation for three months before the experiment was commenced. Its blood was repeatedly examined, but never showed the slightest reaction with the *Micrococcus melitensis.* Milk was removed on several occasions, and the deposit obtained by centrifugalisation plated ; no signs of the specific micrococcus were observed. On June 27 the goat was fed on infected milk obtained from Goat No. 2. On June 28 mixed milk, obtained from an infected herd, was given. Feeding with this milk was continued until August 16. The blood serum was examined weekly during June, July, and August, but never showed the slightest power of agglutinating the *Micrococcus melitensis.* On September 4 the goat was fed with an emulsion in water of an agar growth of the *Micrococcus melitensis* isolated from the spleen of man. This feeding was continued every other day until the growth of *Micrococcus melitensis* on six agar slopes had been consumed. Examination of the blood for agglutinating reaction, and of the milk for the *Micrococcus melitensis*, was continued weekly. On October 6 the blood serum, diluted 1/10, was found to give an immediate reaction with the *Micrococcus melitensis.* On October 8, 5 c.c. of blood were removed from the jugular vein, and planted out in broth-tubes. After seven days' incubation at 37° C. the broth-tubes were found to be sterile. On October 8 blood was again removed from the jugular vein, but the *Micrococcus melitensis* was not recovered. On October 18 the blood reaction was found to be the same as on the 6th of that month ; dilutions above 1/10 failed to give any reaction. On the 23rd, 10 c.c. of the milk were centrifugalised, and the deposit plated ; the *Micrococcus melitensis* was recovered in small quantity. On October 30 the *Micrococcus melitensis* was found in considerable quantity in the milk. On November 2 the blood serum, diluted 1/20, gave a reaction with the *Micrococcus melitensis.* On November 3 the milk became scanty and thin and serous in character ; the microbe could no longer be isolated from it. On November 6 the milk secretion was almost arrested, and on the 13th it had disappeared completely. On November 9 the blood reaction was found to have risen slightly, a dilution of 1/40 causing a complete agglutination of the *Micrococcus melitensis.*

Remarks.—The excretion of the *Micrococcus melitensis* in the milk did not take place until 50 days after the first feeding with the agar culture derived from the spleen of man, and persisted for only three days.

III. To Determine the Mode in which Goats become Infected.

It appeared possible that goats might become infected—

(*a*) By feeding on infected dust.

(*b*) By feeding on infected milk.

(*c*) By inoculation through the agency of infected mosquitos.

(*d*) By inoculation through the agency of infected blood-sucking flies.

(*e*) By direct transmission from mother to kid.

(a) *To Determine the Possibility of Infecting Goats by Feeding them on Infected Dust.*

Goat No. 13.—This goat was in full milk when bought. It was taken to the Lazaretto and placed in a room quite apart from the infected goats. Before the experiment was commenced the blood was repeatedly examined, but no signs of a reaction were observed. On July 13 dust, infected with goat's urine containing the *Micrococcus melitensis* and then dried, was sprinkled over the food. This was done daily until July 22, when dust infected from a case of Mediterranean Fever was used. This dust, dried for 24 hours at room temperature, was sprinkled over the food for a further period of three weeks. The blood was tested weekly for a reaction with the *Micrococcus melitensis*, and on August 3 the blood serum, diluted 1/10, was found to give an instantaneous reaction. The examination of the blood was continued, but the serum reaction never rose above a dilution of 1/10. Five cubic centimetres of blood were removed once a month from the jugular vein, but the *Micrococcus melitensis* was not isolated.

Every week 10 c.c. of the milk were centrifugalised, and the deposit plated. On October 16 the *Micrococcus melitensis* was isolated from the milk. No rise of temperature was ever observed. The goat is still under observation.

Remarks.—This experiment proves that a goat can be infected by feeding on dust infected with urine from Mediterranean Fever patients. The excretion of the *Micrococcus melitensis* in the milk appears to be a late phenomenon, as it was not seen until 74 days after the blood reaction.

Goat No. 14.—This experiment was conducted on the same lines as the one just described. The dust, however, was often slightly moist, instead of being thoroughly dried as in the case of Goat No. 13. The feeding was commenced on July 20, and continued until September 1. The blood was tested weekly for a reaction with the *Micrococcus*

melitensis. On September 3 the blood serum, diluted 1/10, gave a distinct reaction. On October 2 the blood serum, diluted 1/20, caused instantaneous clumping of the *Micrococcus melitensis*, but on October 24 the working dilution was only 1/10. Every week 10 c.c. of the milk were centrifugalised, and the deposit plated, but up to the present the microbe has not appeared in the milk. The goat is still under observation.

Remarks.—As the dust was imperfectly dried, it was thought that Goat No. 14 would have been more seriously affected that Goat No. 13, and it was expected that the *Micrococcus melitensis* would appear in the milk at an earlier date.

(b) *To Determine the Possibility of Infecting Goats and Kids by Feeding them on Infected Goat's Milk.*

It is the custom to feed young kids on milk, and this mode of infection appeared probable, but whether the infection so acquired will persist until the adult stage can only be proved by keeping the animals under observation for a prolonged period.

The histories of Goat No. 8 and Kid No. 9 show that a blood reaction may be acquired in this manner. Goat No. 8 is still under observation. Kid No. 9 was killed, but the *Micrococcus melitensis* was not isolated from its organs, so a true infection did not appear to have taken place in this case.

Five other kids have been fed on infected milk, and are being kept under observation.

(c) *To Determine the Possibility of Infecting Goats through the Agency of Mosquitoes.*

In another section of this report we have shown that *Culex pipiens* and *Stegomyia fasciata* may carry the *Micrococcus melitensis*, consequently it appeared desirable to test by actual experiment whether the microbe could be conveyed from an infected to a healthy goat through their agency.

Culex pipiens, *Stegomyia fasciata*, and *Acartomyia Zammitii* were bred from larvæ. About 50 imagos of each kind were placed in separate cages and fed on the goats from whose blood Zammit had previously recovered the *Micrococcus melitensis.* The cages were transferred to the healthy goats after periods which varied in each series of experiments. In the first series the interval between the feeding on the infected and healthy goats was 48 hours, in the second series the interval was 72 hours. Forty-eight hours after feeding on the healthy goats the mosquitoes were again transferred to the infected goats. The blood of each healthy goat employed in the experiments was tested twice a week for a reaction with the *Micrococcus melitensis.* The experiments

were continued for two months. It was found that on an average the mosquitoes only lived for about 14 days, so fresh batches had to be employed as the old ones died off.

The healthy goats never showed the slightest sign of a blood reaction with the *Micrococcus melitensis.*

In these experiments the cages could not be fastened to the goats for a longer period than two hours, as the animals struggled violently when kept in one position for a longer time. It was thought that the failure might have been due to an unsuitable selection of the intervals between the various feedings, and to the comparatively short time that the mosquitoes were in actual contact with the animals.

An attempt was now made to imitate the conditions actually occurring in daily life. A small recess in one of the large rooms in the Lazaretto was divided into two compartments, each large enough to hold a goat comfortably, by means of a partition made of coarse wire netting fastened below to a board 3 feet in height. The board was fixed to the floor of the recess by cement, so that urine could not possibly pass from the infected to the healthy goat. The top and front of the recess were made mosquito proof, and a small mosquito-proof door was provided for each compartment. Brackets were fastened on the walls of each compartment out of reach of the goats. Jars containing water full of larvæ in the pupal stage were then placed on the brackets in the compartment containing the infected goat, and jars containing water free from larvæ were placed on the brackets in the compartment for the healthy goat. The wooden portion of the partition prevented the goats coming into actual skin contact, but the large apertures in the wire netting readily permitted the mosquitoes to fly from one compartment to the other. This experiment was continued for a month, fresh water containing larvæ being placed in the compartment containing the infected goat as the imagos died off. At a later period imagos were bred out in cages and then let loose in the infected compartment. The blood of the healthy goat was examined twice a week, but it never showed the slightest sign of a reaction with the *Micrococcus melitensis.* The goat is still under observation.

Result.—Up to the present time infection has not been conveyed to healthy goats by means of mosquitoes which had previously fed on infected goats. The failure of the experiments may be due to the *Micrococcus melitensis* being present in the blood of infected goats in too small quantity to be conveyed by mosquitoes. In the feeding experiments already described 5 c.c. of blood were frequently taken from the jugular vein of infected goats, and yet the *Micrococcus melitensis* was never isolated. Zammit succeeded in isolating the *Micrococcus melitensis* from the blood of the infected goats used in the experiments once only, all his further attempts failed.

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Knowing how intimately goats live with the Maltese people, it seems probable that, if mosquitoes do convey infection to goats, the infecting microbe is obtained from man and not from the goat.

(d) *To Determine the Possibility of Infecting Goats through the Agency of Blood-sucking Flies.*

Stomoxys calcitrans having been noticed to infest the goats in Malta, it was thought that this fly might act as an infecting agent. Cages containing about 50 of these flies were placed on the infected goats used in the mosquito experiments, and then transferred after varying periods to a healthy goat. It was soon noticed, however, that unless the flies were fed every 48 hours a very heavy mortality took place. Accordingly the interval between the feedings was mainly kept to this period. The flies fed extremely well on the goats, and their bodies were noticed to be distended with blood. The healthy goat's blood was examined twice a week, but no sign of a reaction with the *Micrococcus melitensis* was ever obtained. The experiments were continued for two months, fresh batches of flies being employed as the old ones died off.

Result.—Up to the present infection has not been conveyed to healthy goats by *Stomoxys calcitrans* which had been previously fed on infected goats. The cause of failure may be that suggested in the mosquito experiments. *Stomoxys* will bite man, and it may be that infection is conveyed from man to goat by its means.

The *Micrococcus melitensis* has not yet been isolated from *Stomoxys* fed on goats and monkeys, and on humanitarian grounds it has not been possible to feed the flies, which produce much swelling and irritation, on patients suffering from Mediterranean Fever.

(e) *To Test the Possibility of Direct Transmission of Infection from Mother to Kid.*

When the herd of goats at Pieta was being examined, it was noticed that one of them (No. 19) was pregnant. The goat only gave one pint of milk, which was normal in appearance, and was used for feeding the kids attached to the herd. The blood of the goat was examined, and it was found that the serum, diluted 1/100, caused immediate agglutination of the *Micrococcus melitensis*. The animal was then purchased, and brought to the Lazaretto on July 16. On July 17 10 c.c. of the milk were centrifugalised, and the deposit spread on glucose-litmus-nutrose-agar plates. After four days' incubation at 37° C., all the plates were found densely crowded with colonies of the *Micrococcus melitensis*. The milk was examined weekly until October 23, and on each occasion a rich growth of the microbe was obtained. On August 14 and September 14, 5 c.c. of blood were removed from

the jugular vein and planted out in broth-tubes. On both occasions the tubes were found quite sterile after 10 days' incubation. On October 25 it was noticed that the blood reaction had diminished, a dilution of 1/50 producing complete agglutination, but 1/100 merely produced a few small clumps. On the afternoon of October 25 the goat dropped her kid, which was a male, and quite strong and healthy, it was numbered 19A. On October 27, 5 c.c. of blood were taken from the jugular vein of the goat, but the *Micrococcus melitensis* was not recovered. The milk was examined on the same day, and found to be teeming with the specific *Micrococcus melitensis.* On October 30 and November 3 the milk was examined again, but no traces of the *Micrococcus melitensis* could be discovered. On November 2 the blood reaction was tested again, and it was found that the serum, diluted 1/125, caused complete agglutination, and small clumps were produced by a dilution of 1/200. On November 13 the serum, diluted 1/200, caused a complete reaction. At the end of November the *Micrococcus melitensis* again appeared in the milk.

Kid (19A) dropped by Goat No. 19 on October 25. On October 26 the blood was tested for agglutination, and it was found that the serum, diluted 1/50, caused an immediate complete reaction, whilst a dilution of 1/100 only produced a few small clumps. It was noticed that the blood reaction corresponded exactly to that of the mother on the day the kid was born. On November 4 the blood reaction was found unchanged, but on November 13 a dilution of only 1/20 was found capable of producing a complete agglutination of the *Micrococcus melitensis.* The kid was then killed and cultures were made from the organs. The *Micrococcus melitensis* was not isolated.

Remarks.—This experiment appears to prove that agglutinins are transferred *in utero* from mother to kid. It also shows that pregnancy may progress in a perfectly normal manner when the mother is markedly infected. The suppression of the excretion of *Micrococcus melitensis* in the milk for nearly a month after the birth of the kid is interesting.

IV.—Experiments to Determine whether it is Possible to Destroy the *Micrococcus melitensis* by Pasteurisation of the Infected Milk.

Experiment I.—Milk was drawn from goats 1, 2, 3, 5 and 6 and thoroughly mixed. This mixed milk was selected for experiment as it contained thick ropy masses, and it was thought that these might act as protecting envelopes to the specific micrococci, so that if such a milk were sterilised by Pasteurisation, it might safely be concluded that any ordinary normal looking milk would be equally sterilised by the same operation.

One loopful of the mixed milk was stroked on a series of surface plates to act as a control. The mixed milk was then heated on a water-bath to 68° C. and this temperature was maintained for 10 minutes. The milk was then rapidly cooled and 10 c.c. of the sterilised milk were spread over 20 litmus-nutrose-agar plates.

Results.—After four days' incubation at 37° C. the control plates were found densely crowded with colonies of the *Micrococcus melitensis*; the plates made from the Pasteurised milk remained free from any signs of the specific *Micrococcus melitensis*, even though the incubation was continued for 14 days.

Experiment II.—This served as a control of Experiment I, the same procedure being followed. The *Micrococcus melitensis* appeared in the control plates, but the plates made with the Pasteurised milk again remained perfectly sterile.

Summary.

1. Judged by the serum reaction, 41 per cent. of the goats in Malta are infected.

2. Ten per cent. of the goats supplying milk to various parts of Malta appear to excrete the *Micrococcus melitensis* in the milk.

3. The excretion of the specific microbe may continue steadily for three months without any change occurring in the physical character or chemical composition of the milk, and without the animal exhibiting any signs of ill health.

4. Some infected goats may lose flesh and their coats may become thin; they may also suffer from a short hacking cough. A febrile condition, however, has not been observed.

5. Goats may have a marked blood reaction (1/100), and yet never excrete the *Micrococcus melitensis* in the milk.

6. If the blood serum or milk does not agglutinate the *Micrococcus melitensis*, the specific microbe is not found in the milk.

7. There is no constant relation between the amount of agglutinins in the milk or blood, and the excretion of *Micrococcus melitensis* in the milk; but the higher the dilution of the serum which agglutinates the *Micrococcus melitensis*, the greater is the probability of finding the *Micrococcus melitensis* in the milk.

8. The excretion of the *Micrococcus melitensis* in the milk may be intermittent, appearing for a few days and then disappearing for a week or more.

9. A blood reaction may exist for some weeks before the *Micrococcus melitensis* is excreted in the milk.

10. If blood cannot be obtained the milk reaction with the *Micrococcus melitensis* (Zammit's test) is a good indication of infection.

11. The milk agglutination test is a surer indication of the *Micrococcus melitensis* being excreted in the milk than the serum reaction.

12. Monkeys and goats can be infected by feeding with cultures of *Micrococcus melitensis* isolated from milk, and also by feeding with infected milk itself.

13. The incubation period in feeding experiments appears to vary between three and four weeks.

14. Monkeys infected by feeding sometimes suffer from a typical wave of fever and lose flesh, at other times they show no obvious signs of ill health, and may even gain in weight.

15. When monkeys become infected by feeding with milk, the lymphatic glands always contain far more colonies of the *Micrococcus melitensis* than the spleen. This fact suggests that the specific micrococci contained in the food are carried to the lymphatic glands and there undergo considerable multiplication. It has not yet been proved that the mesenteric glands are always infected at an earlier date than the femoral and axillary glands, but Experiment IV, feeding with milk, shows that this may be the case at times.

16. It has been demonstrated that goats may become infected by feeding on dust polluted with urine from cases of Mediterranean Fever. The excretion of *Micrococcus melitensis* in the milk resulting from such infection, is a late phenomenon, only appearing about 74 days after the blood reaction has developed.

17. It has not been possible yet to convey infection from goat to goat by means of mosquitoes or *Stomoxys calcitrans.* If mosquitoes do carry the infection, it seems more probable that the microbe is transferred from man to goat, than from goat to goat.

18. Agglutinins may be transferred from the mother to the fœtus *in utero.* Pregnancy appears to follow a normal course in infected goats.

19. Pasteurisation (68° C. for 10 minutes) destroys the *Micrococcus melitensis* present in infected goat's milk.

VII.—MOSQUITOES AS A MEANS OF DISSEMINATION OF MEDITERRANEAN FEVER.

By Major W. H. Horrocks, R.A.M.C., and Captain J. C. Kennedy, R.A.M.C.

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(Plate 2.)

Epidemiological inquiries having shown that while the consumption of infected milk may, and probably does, account for much of the Mediterranean Fever amongst the Maltese, yet many cases occur among the military and naval populations in Malta which cannot be attributed to this cause. Accordingly, a study of mosquitoes as possible carriers of the *Micrococcus melitensis* was commenced. The work done may be arranged in three parts :—

Part I.—A study of the species of mosquitoes found in Malta, and their distribution in the island.

Part II.—Examination of the species to determine whether any of them act as carriers of the *Micrococcus melitensis.*

Part III.—Experiments to determine whether any of the species are capable of conveying infection from cases of Mediterranean Fever occurring in man to healthy monkeys, or from infected to healthy monkeys.

Part I.—Study of the Species of Mosquitoes Found in Malta.

Mosquitoes were caught in the Military Hospital, Valletta; Military Hospital, Cottonera; Military Hospital, Citta Vecchia; Military Hospital, Imtarfa; Fort Chambray, Gozo; Military Hospital, Forrest Hill; Floriana Barracks; Civil Hospital, Floriana; Naval Hospital, Bighi; Fort Ricasoli; Barracks, Lower St. Elmo; Sliema; Birchircara; Barracks Imtarfa; Barracks Cottonera. The following species were recognised :—

Culex pipiens.
Culex fatigans.
Culex spathipalpis.
Stegomyia fasciata.
Acartomyia Zammitii.

All the species, except *Culex spathipalpis*, were found at times full of blood. *Acartomyia Zammitii* and *Stegomyia fasciata* attack human beings both day and night. Whilst *Culex pipiens* and *Culex fatigans* only become troublesome at night.

The distribution of the mosquitoes found was chiefly as follows:—

Military Hospital, Valletta—
Culex pipiens.
Culex fatigans (very few).
Acartomyia Zammitii } These are very rare after
Stegomyia fasciata } the end of September.

Military Hospital, Cottonera—
Culex pipiens.
Culex fatigans.
Culex spathipalpis.
Acartomyia Zammitii.
Stegomyia fasciata.

Military Hospital, Citta Vecchia—
Culex pipiens.
Culex spathipalpis } Comparatively rare.
Stegomyia fasciata }

Military Hospital, Imtarfa—
Culex pipiens (very common).
Culex spathipalpis (rare).

Fort Chambray, Gozo—
Culex pipiens.
Culex fatigans.
Acartomyia Zammitii.

Floriana Barracks—
Culex pipiens.

Civil Hospital, Floriana—
Culex pipiens.
Culex fatigans.
Stegomyia fasciata.

Ricasoli Fort—
Culex fatigans.
Culex pipiens.
Acartomyia Zammitii.
Stegomyia fasciata.

Lower St. Elmo Barracks—
Culex pipiens.
Acartomyia Zammitii.
Stegomyia fasciata.

The *Acartomyia Zammitii* breeds in the salt pools found close to the sea, and it appeared important to determine whether this mosquito invades the small towns and barracks in the interior of the island. More than 600 mosquitoes were collected from Citta Vecchia and Imtarfa, and yet *Acartomyia Zammitii* was never found once among them. Severe outbreaks of Mediterranean Fever having occurred at

both these places, the distribution indicates that, even if Mediterranean Fever be a mosquito-borne disease, the probabilities are against *Acartomyia Zammitii* being an important infecting agent.

The seasonal prevalence of the mosquitoes is also interesting in view of the fact that cases of Mediterranean Fever occur amongst the military and naval garrison during the winter months. Looking at the question from this point of view the *Culex pipiens* would appear to be likely to play an important part in conveying infection.

Part II.—Examination of Mosquitoes to Determine whether any Species act as Carriers of the *Micrococcus melitensis.*

The following procedure was adopted in the examination of mosquitoes. Specimens full of blood were caught in boxes and stupified with chloroform. Each mosquito was then placed on a sterile glass slide, and needles being placed on the thorax and penultimate segment of the abdomen, gentle traction was exerted. With a little practice it was found possible to completely separate the parts, and leave the coagulated blood on the slide practically free from all contaminating fluids contained in the body of the mosquito. A few drops of sterile water were now added to the blood, and the whole was thoroughly mixed. The fluid was then drawn up in a sterile pipette, and transferred to litmus-nutrose-glucose-agar plates, and carefully spread over the surface of the medium. The plates were then incubated at 37° C., and examined in the usual way at the end of four days.

The first recovery was made on September 4 by one of us (H) from a mosquito (*Culex pipiens*) caught full of blood in the Lazaretto. One plate made in the manner described above contained 34 colonies of the *Micrococcus melitensis*. The micro-organism recovered was subjected to the most rigorous tests, and its pathogenicity was proved by injecting the growth on an agar slope obtained from one of the colonies on the plate (see Monkey C).

The second recovery was made on September 15 (by K) from a *Stegomyia fasciata* caught full of blood in the Mediterranean Fever wards of the Military Hospital, Valletta. One plate contained 24 colonies of the *Micrococcus melitensis*. The pathogenicity of this culture was also tested (see Monkey 101).

The third recovery was made (by H) on September 23 from a *Culex pipiens* caught in the Mediterranean Fever ward at the Naval Hospital, Bighi (Plate 2). The plate contained 100 colonies of the *Micrococcus melitensis.*

The fourth recovery was made (by H) on September 24 from a *Culex pipiens* caught in the Civil Hospital, Florian. The plate in this case only contained four colonies of the *Micrococcus melitensis*.

Blood from the stomach of a *Culex pipiens* caught in the Naval Hospital, Bighi, Malta. Plated on glucose-nutrose-litmus-agar. Incubated for 4 days at 37° C.

From photo. by Staff-Sergeant Rossiter, R.A.M.C.

It was noticed that, though several plates were inoculated with the blood from the mosquito, all the colonies on each occasion appeared in one plate.

Bearing in mind the work done by Shaw, Zammit, and Gilmour on the blood of patients suffering from Mediterranean Fever, the number of colonies which appeared to be present in the small quantity of blood contained in the mosquitoes is very remarkable, and suggests that either the *Micrococcus melitensis* undergoes multiplication in the mosquito, or else the micrococci are phagocyted in corpuscles which are broken up by the manipulations on the glass slide.

The following tables show the number and species of the mosquitoes which have been dissected up to the present time :—

Table A (Mosquitoes dissected by H.).

	Culex pipiens.	*Culex fatigans.*	*Stegomyia fasciata.*	*Acartomyia Zammitii.*	Total.
Military Hospital, Valletta	6	0	3	11	20
Civil Hospital, Floriana	63	0	24	0	87
Naval Hospital, Bighi	13	0	7	5	25
Military Hospital, Citta Vecchia	93	0	2	0	95
Military Hospital, Imtarfa	6	0	0	0	6
Barrack Room, Citta Vecchia	8	0	0	0	8
Military Hospital, Forrest	4	0	2	0	6
Military Hospital, Cottonera	13	0	0	0	13
Barracks, St. Andrews	4	0	0	0	4
Barracks St. Elmo......	0	0	3	0	3
Lazaretto, Manoel	3	0	1	0	4
Barracks, Floriana	4	0	0	0	4
Total	217	0	42	16	275

Three recoveries of *Micrococcus melitensis* were made out of 275 mosquitoes dissected. It should be noted, however, that 95 mosquitoes were collected at Citta Vecchia, where the cases of Mediterranean Fever are mostly chronic, Citta Vecchia being a kind of sanatorium for the acute cases treated in Valletta and Cottonera. There were also few acute cases in the Civil Hospital, Floriana, at the time when the 87 mosquitoes were collected there.

Table B (Mosquitoes dissected by K. up to end of October, 1905).

Hospital.	*Culex pipiens.*	*Culex fatigans.*	*Stegomyia.*	*Acartomyia.*	Total.
Military Hospital, Valletta	109	3	45	32	189
Cottonera	5	1	—	—	6
Citta Vecchia	159	—	1	—	160
Imtarfa	20	—	—	—	20
Civil Hospital, Valletta	40	–	14	—	54
Naval Hospital, Bighi	2	—	—	—	2
Total	335	4	60	32	431

The mosquitoes in Table B were all captured in wards containing Mediterranean Fever patients.

Out of the total of 431 from these infected places, only one was found to contain *Micrococcus melitensis*. This was a *Stegomyia*, caught in 20A Ward, Valletta Military Hospital, on September 15. Twenty-four colonies of the microbe were obtained from the stomach.

Table C.—Mosquitoes caught in places where there were presumably no Mediterranean Fever Patients (dissected by K. up to the end of October).

Place.	*Culex pipiens.*	*Culex fatigans.*	*Culex Spathipalpis.*	*Stegomyia.*	*Acartomyia.*	Total.
Military Hospital, Valletta	58	1	—	9	4	72
Military Hospital, Cottonera	8	1	—	1	—	10
Military Hospital, Imtarfa	6	—	1	—	—	7
Military Hospital, Citta Vecchia	44	—	—	—	—	44
Military Hospital, Forrest	4	1	—	4	3	12
Floriana Barracks	9	—	—	—	—	9
Lower St. Elmo Barracks	6	—	—	3	13	22
Fort Ricasoli	7	1	—	2	1	11
Gozo	—	—	—	—	1	1
Valletta	1	—	—	1	—	2
Total	143	4	1	20	22	190

No *Micrococcus melitensis* was recovered from any of these.

The *Micrococcus melitensis* was only recovered from four out of a total of 896 mosquitoes dissected. It must, however, be noted that some 255 mosquitoes were obtained from Citta Vecchia, where the cases of Mediterranean Fever are mostly chronic, and about 200 other mosquitoes were caught in places where there were no known cases of Mediterranean Fever. Deducting these numbers from the total, the result would be four infected mosquitoes out of about 450 mosquitoes collected in presumably infected places.

This result was not unexpected; considering the small numbers of the specific micrococci which are found in the peripheral blood of Mediterranean Fever patients, mosquitoes could not possibly be infected in great numbers, or Mediterranean Fever would be much more prevalent than it is at present.

Experiments to Test the Virulence of the Micrococcus melitensis *isolated from* Culex pipiens *and* Stegomyia fasciata.

Culex pipiens. *Monkey C.*

The monkey used in this experiment was brought from Calcutta and kept under observation for nearly two months before the experiment was commenced. Its blood was tested on many occasions, but no signs of a reaction with the *Micrococcus melitensis* were observed. On September 4 one of the colonies on the nutrose-agar plate, made with blood from the *Culex pipiens* caught in the Lazaretto, was planted on an agar slope, and on September 19 the growth resulting, emulsified in salt solution, was injected subcutaneously into Monkey C. A wave of fever followed, and on September 29 the blood reacted in a dilution of 1/10. On October 11 the blood serum, diluted 1/50, was found to cause immediate agglutination of the *Micrococcus melitensis*. On October 14 the monkey was killed. Cultures were made from the spleen, kidneys, liver, bile, mesenteric, femoral, and axillary glands, and hearts' blood. The micro-organism was recovered from the spleen and heart's blood; it was also found in considerable quantity in all the plates from the glands.

This monkey was also used for experiments on the conveyance of infection by mosquitoes.

Remarks.—The wave of fever, blood reaction, and recovery of *Micrococcus melitensis* from the organs show that the culture isolated from *Culex pipiens* was undoubtedly virulent.

Stegomyia fasciata. Monkey No. 101.

Monkey No. 101 had been under observation for several weeks, and its blood repeatedly tested, with negative results, before the experiment was commenced.

The *Micrococcus melitensis* was isolated from the mosquito on September 15 and sub-cultured on September 19. On September 24 an emulsion of the growth on an agar slope was injected subcutaneously into Monkey No. 101. A well-marked wave of fever resulted. On the sixth day after the injection the blood serum gave a complete reaction in a dilution of 1/10, and the temperature rose to 106°·8. On October 15 the temperature fell to the "normal level," but a few days later an irregular secondary wave of fever set in and the agglutination reaction increased. On October 22 the working dilution of serum was 1/50, and on the 29th 1/300. On November 12 the monkey was killed with chloroform. The blood serum, tested just before death, was found, when diluted 1/1000, to cause immediate agglutination of the *Micrococcus melitensis*.

The microbe was recovered in great profusion from the spleen and lymphatic glands, in less quantity from the liver, and very sparsely from the kidney. Each of six broth tubes, inoculated with 0·5 c.c. of blood from the heart, was found to contain the micrococcus.

This monkey was also used for experiments on the conveyance of infection by mosquitoes.

Remarks.—The marked wave of fever, strong blood reaction, and the presence of the *Micrococcus melitensis* in the blood and all the viscera show that the culture isolated from the *Stegomyia fasciata* was very virulent.

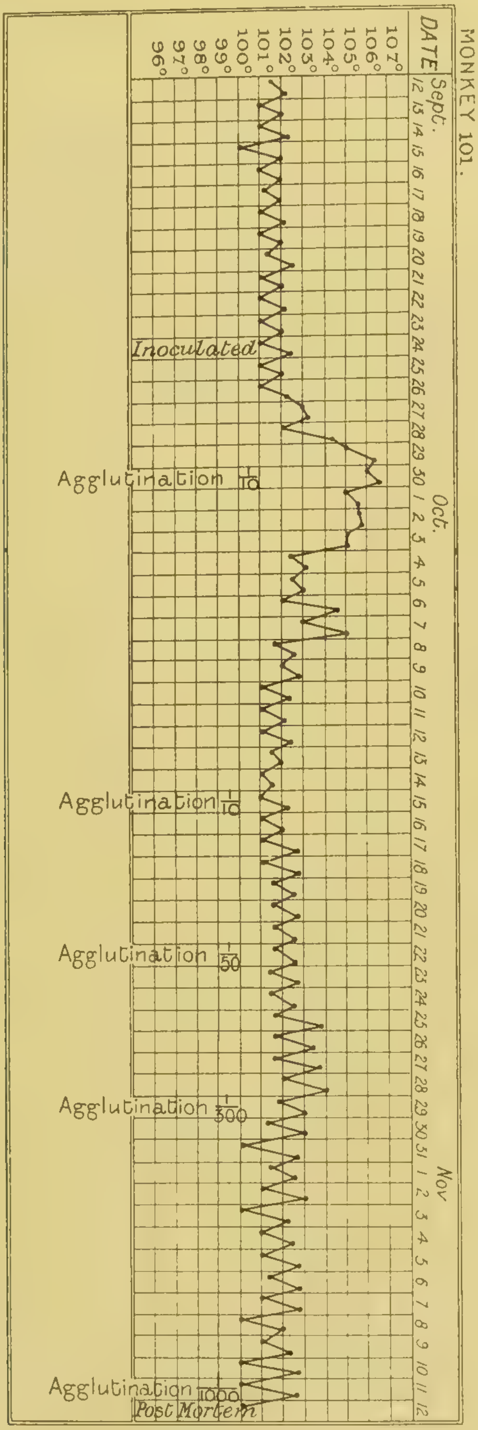
The chart (p. 77) shows the wave of fever during the experiment.

Part III.—To determine whether *Culex pipiens* and *Stegomyia fasciata* can convey the Infection of Mediterranean Fever from Monkey to Man, Man to Monkey, and Monkey to Monkey.

Conveyance of Infection from Monkey to Man.

This experiment was not designed, but occurred in the following manner. On October 1 Monkey No. 6, infected by feeding, was being examined (by H.) in the verandah of the Lazaretto. Carlo Mifsud, the attendant in the Lazaretto, suddenly pointed to a mosquito, full of blood, resting on the table, and said, "that mosquito has just bitten me and I could not brush it away without letting go the Monkey." The mosquito was at once captured and dissected, with the results already detailed under the first recovery of the *Micrococcus melitensis* from *Culex pipiens*. On the day the mosquito was captured Carlo's blood was carefully examined, but no reaction with the *Micrococcus melitensis* was obtained. His temperature was also taken and found to be perfectly normal. The boy declared that he was perfectly well, and was much amused by the examination to which he was subjected. On October 11

he complained of feeling ill and returned to his home in Birchircara. On October 18 he was found to be suffering from fever and his blood



serum caused immediate agglutination of the *Micrococcus melitensis*. The boy still has fever (November 20), temperature ranging between 102° and 103°, and is undoubtedly suffering from a typical attack of

Mediterranean Fever. He stated that he had constantly drunk raw goat's milk obtained from F—— of Balzan; but for some 12 weeks before his illness he was employed from 7 A.M. to about 8 P.M. in the Lazaretto, and whilst working there he obtained milk from healthy goats which were being kept under observation for future experiments. He also stated that there were no cases of fever in his house at Birchircara. The infection of the mosquito might easily have been acquired from the infected monkeys in the Lazaretto. At the time there were several monkeys which had been infected by feeding and by subcutaneous injection, and whose blood yielded the *Micrococcus melitensis* on culture. As soon as monkeys became infected it was the custom to bring them daily out of the dark mosquito-proof rooms into the verandah for better observation. It is not difficult to imagine that the mosquito which bit "Carlo Mifsud" had previously fed on these monkeys and so had taken the *Micrococcus melitensis* into its stomach.

Conveyance of Infection from Cases of Mediterranean Fever occurring in Man to Healthy Monkeys.

Experiment I.—*Conveyance of Infection by* Culex pipiens. On August 21 a batch of mosquitoes bred out from larvæ were fed on a patient in the Valletta Hospital. There were about 50 of them in the cage and many were found full of blood. On the evening of August 23 they were fed on Monkey No. 22. On the same day another batch of mosquitoes were fed on a patient in the Valletta Hospital; on August 24 and 25 this batch was fed on Monkey No. 22. The feedings were done in the evening, but it was noticed that very few of the mosquitoes attacked the monkey. It was therefore decided to place the healthy monkey in a mosquito-proof cage and let the mosquitoes loose inside the cage. Accordingly, on August 31 this was done and another batch of mosquitoes fed on a patient was also let loose at the same time. On September 4 another batch was set free in the cage. On September 19 still another batch of mosquitoes was let loose. A jar full of water was placed on a bracket inside the mosquito cage, and many larvæ were eventually found in the water. The blood of Monkey No. 22 was carefully examined once a week for a reaction until October 25, when a severe attack of dysentery set in. On November 17 the monkey, being *in extremis*, was killed with chloroform. At the *post-mortem* examination miliary tubercles were found in the organs, and the liver was "waxy." Cultures were made in the usual manner, but the *Micrococcus melitensis* was not isolated.

Remarks.—In this experiment over 250 mosquitoes were employed, but not more than half of them absorbed blood from the Mediterranean Fever patients. Careful examination of the mosquitoes in the cage occupied by the monkey was made from day to day, but none of them were noticed full of blood.

Experiment II.—This was conducted on the same lines as No. I, with the exception that the monkey was placed in a small mosquito-proof box instead of a large cage, the idea being to bring the mosquitoes in more intimate contact with the monkey. The box had a double bottom, the upper being made of narrow bars and the lower of solid wood. Flat dishes containing water were placed in the space below the narrow bars. At intervals of 48 hours mosquitoes were placed in the cage. About 300 mosquitoes, which had fed on patients, were used, but of these only 80 containing blood were counted. Monkey No. 18 was used in this experiment and its blood was tested weekly for a reaction with the *Micrococcus melitensis.* It became seriously ill in October and was chloroformed on November 17. At the *post-mortem* examination a condition of things very similar to Monkey No. 22 was found. Cultures were made in the usual manner, but no signs of *Micrococcus melitensis* appeared.

Conveyance of Infection by Culex pipiens *from Infected to Healthy Monkey.*

A small box covered with mosquito netting was divided into two compartments by wire-netting fastened below to a board let into a groove in the floor, a false bottom made of wire was put in each compartment. These precautions were taken in order to prevent the passage of urine from one side of the box to the other. Monkey C, suffering from a wave of fever, having been placed in one compartment and Monkey No. 3, quite healthy, in the other about 400 mosquitoes were let loose in the compartment occupied by Monkey C. Next day 200 more mosquitoes were introduced. Unfortunately Monkey No. 3 died suddenly four days after the experiment was commenced. Another healthy monkey was then placed in the box and every day for a week batches of about 200 mosquitoes were let loose in the cage. The healthy monkey never showed any signs of infection.

Conveyance of Infection by Stegomyia fasciata.

Experiment I (from man to monkey).—Monkey No. 16 was placed in a large mosquito-proof box, and 200 mosquitoes, which had fed on patients in the Cottonera Hospital, were placed in the cage. The mosquitoes remained alive for a week. The blood of the monkey was repeatedly examined, but no signs of a blood reaction were observed, though the monkey was kept under observation for two months.

Experiment II (from man to monkey).—A cage containing over 100 mosquitoes was placed on a patient in the Cottonera Hospital on October 2. On October 4, 5, and 6 the cage was placed on Monkey No. 17. On each occasion some of the mosquitoes were noted to feed freely. On October 6 a cage full of mosquitoes, fed 48 hours previously on a patient in the Valletta Hospital, was placed on the monkey. On

October 7, 8, 9, and 10 the cage was again applied to the monkey. The blood of Monkey No. 17 has been subjected to repeated examination, but no signs of a blood reaction have been observed up to the present time.

Experiment III (from monkey to monkey).—On September 30 a cage full of mosquitoes, bred from larvæ, was placed on Monkey No. 101, then at the top of a wave of fever. Next day the cage was again placed on Monkey No. 101, so as to ensure as far as possible that all the mosquitoes should have an opportunity of taking up blood. On October 3 and 4 the mosquitoes were fed on Monkey No. 14. On October 5 and 6 the mosquitoes were again placed on Monkey No. 101, but on both days many dead mosquitoes were found in the cage. On October 7 the mosquitoes still alive were fed on Monkey No. 14. On October 9 all the mosquitoes were found dead. Monkey No. 14 has been kept under observation up to the present time, but the serum has never reacted.

Remarks.—The results of the experiments were disappointing, but not unexpected. The dissections of mosquitoes obtained from the wards containing Mediterranean fever patents, showed that under the most favourable conditions not more than 1 per cent. would carry the *Micrococcus melitensis.* In the experiments on the conveyance of infection from man to monkey, endeavours were made to feed as many mosquitoes as possible, but it was practically impossible to feed more than 300 mosquitoes at one time on the patients in the wards, and of these probably not more than one-half would take up blood at the first feeding; so that even with this large number of mosquitoes there was only a probability that one would carry the infecting microbe.

In the conveyance of infection from monkey to monkey, the feelings and interests of the patients did not militate against the use of any desired number of mosquitoes, but the monkey experiments presented their own peculiar difficulties. The attempts to isolate the *Micrococcus melitensis* from the blood of infected monkeys clearly showed that the specific microbe was present in the blood to a small extent, and that it appeared at very uncertain periods after infection, as judged by the serum reaction, had taken place. The *Micrococcus melitensis* also did not seem to persist in the blood for any long period after its recovery. From the fifth to the tenth day after the appearance of the agglutination was found to be the best time for its recovery from the blood. Though often the attempts made during life to isolate the micrococcus proved failures, yet the specific microbe was occasionally found in the blood obtained at the *post-mortem* examination. Again, monkeys displayed an enormous difference in their powers of resistance to infection; for instance, Monkey No. 110, intended for mosquito experiments, could not be infected, though he received subcutaneously at various times the growth of *Micrococcus melitensis* on six agar slopes. Mosquitoes also did

display the same predilection for monkeys as they did for man. It was often noticed that a cage full of *Culex pipiens* might be left for two hours in contact with a monkey, and not a single mosquito would bite. If, however, the same cage were transferred at once to the skin of man, the mosquitoes would commence to feed.

Conclusions drawn as to the Mode of Entrance of the Micrococcus melitensis *into the Human Body, based on the Work done up to End of November,* 1905. (W. H. H.)

(1) There is no evidence that Mediterranean Fever can be contracted by contact with cutaneous surfaces uncontaminated by urine.

(2) Infection can be acquired by the absorption of urine secreted by cases of Mediterranean Fever, and this is probably one way in which workers in hospital become infected.

(3) There is evidence to show that monkeys can be infected by dry dust artificially contaminated with cultures of *Micrococcus melitensis* isolated from the spleen of cases of Mediterranean Fever. The path of absorption may be through the nares, throat, respiratory passages, and alimentary canal. Dry dust contaminated with the urine of cases of Mediterranean Fever has given rise to infection in goats, but not in monkeys, up to the present time. The experience gained during the work performed in Malta during 1904–5 has convinced me that men are more susceptible to infection than monkeys and goats. Shaw's work on ambulatory cases of Mediterranean Fever amongst the Maltese has also shown that opportunities for the creation of infected dust are plentiful in Malta. Infected dry dust as a cause of Mediterranean Fever cannot therefore be discarded. When infection is acquired in this manner the incubation period is probably at least a month.

(4) Mediterranean Fever can be acquired by the absorption of infected goats' milk from the alimentary canal. The incubation period in this case is also probably long, and may even extend to two months.

This mode of infection probably plays a great part in the causation of Mediterranean Fever amongst the Maltese, who drink raw milk drawn at the doors of their houses.

(5) *Culex pipiens* and *Stegomyia fasciata* act as carriers of the *Micrococcus melitensis*, and the case of Carlo Mifsud renders it extremely probable that human beings are infected by the bites of infected mosquitoes.

(6) I believe that infected goats and infected mosquitoes play a greater part in the causation of Mediterranean Fever than the absorption of infected dust.

Preventive Measures.

If the conclusions drawn as to the mode of entrance of the *Micrococcus melitensis* into the human body be accepted, preventive measures should obviously be based on the following lines:—

(1) *Destruction of Infected Goats in Malta.*—The best indication of infection appears to be the milk agglutination test suggested by Zammit; unfortunately the test requires to be performed by a worker of considerable experience, and, judging by my own work, I think the hanging drop is preferable to the capillary tube employed by Zammit. The serum test is easier to perform, and as the experimental work has shown that goats may have a marked blood reaction, and that the *Micrococcus melitensis* may be present in the blood without the specific microbe necessarily appearing in the milk, all goats showing a decided serum reaction (dilution 1/20) should be destroyed. Examination of the milk alone cannot be taken as a basis of action in relation to goats, as we know that the excretion of the *Micrococcus melitensis* in the milk may be intermittent, and goats may be infected for some two to three months before the *Micrococcus melitensis* appears in the milk.

As goats may become infected by eating rubbish polluted with urine in the streets of Malta, and they themselves, when infected, excrete the *Micrococcus melitensis* in the urine, so, adding to the contamination of the public thoroughfares, it is plain that the perambulation of goats through the streets of Malta should be forbidden. The goats should either be milked in their pens, and the milk transmitted to the chief towns in sealed cans, or the goats should be assembled in some central depôt outside the towns, and the yard of the depôt should have a cemented surface, which can be thoroughly cleansed after the milking operations are over. As there is a strong probability that infection is also carried from infected human beings to goats by mosquitoes, the keeping of goats in houses, and in small yards attached to houses, should be forbidden. Goats should be kept in pens as far away from human habitations as circumstances will allow.

(2) *Destruction of the Larvæ of Mosquitoes.*—This is a large order in a place like Malta; but it must be attempted if the disease is to be stamped out. By means of pamphlets, householders should be instructed to apply oil to the surface of all stagnant water on their premises. About 15 c.c. of oil are sufficient for a square metre of surface; the application should be repeated every 15 days in the hot weather. The oiling of stagnant water in the houses of the poor should be performed by the sanitary authority.

(3) Promiscuous micturition about the streets should be forbidden, and a heavy penalty inflicted on any offender. By means of leaflets, the people should be educated to understand the importance of preserving some degree of sanitation in their dwellings, especially in relation to cleansing and flushing W.C.'s. Second class water for flushing purposes should not be made a means of revenue, but should be supplied at cost price.

VIII.—EXPERIMENTS ON MOSQUITOES AND FLIES.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—EXPERIMENTS WITH THE OBJECT OF INFECTING MOSQUITOES ARTIFICIALLY AND OF ATTEMPTING THEREAFTER TO INFECT A MONKEY.

Mosquitoes which had fed on uninfected people were collected full of blood and kept alive for several days by feeding them on a thick emulsion of *Micrococcus melitensis*, thereafter they were fed at regular intervals on Monkey No. 19. This animal had formerly been used for the *Stomoxys* experiment (see p. 66), but the last exposure to infection was on September 17, 25 days before this experiment was started, and no reaction had been detected in its blood.

Between the period from October 12 to November 3 about 40 mosquitoes, which had been treated as just mentioned, fed on this monkey. On October 5 the animal was very ill with dysentery, but no trace of reaction was found in its blood. On the 8th it died, and though a careful *post-mortem* examination was made of all its organs, no *Micrococcus melitensis* was recovered.

Dissections of the infected mosquitoes were made occasionally, and *Micrococcus melitensis* was recovered from the stomach once and from the thorax once; unfortunately in the latter instance the œsophagus had not been excluded from the muscular tissue.

II.—OBSERVATIONS ON *Stomoxys calcitrans.*

During the summer, when visiting the various herds of goats for the examination of blood and milk, I found that the sheds where the goats were housed were infested with a fly that resembled the common house fly, but had a piercing proboscis. I took this to be a *Stomoxys*, and this observation was kindly confirmed by Mr. Austen, of the British Museum, to whom I sent specimens, and who informed me that it was the *Stomoxys calcitrans*, but slightly smaller than the British variety. This fly is to be found all over Malta, and even in houses in town. It attacks viciously both animals and human beings, and its bite is very irritating; it sucks the blood of its victims, and is capable of holding a considerable quantity. Thinking that this fly might have some share in conveying the disease from goat to goat, I had supplies collected from a goat shed where a large number of the goats were infected, and carried out the following experiments.

Experiment 1.—Monkey No. 129, uninfected; blood gives no reaction. From August 15 to 20, flies straight from the goat shed were fed on this monkey; 25 flies bit well. From August 21 to 24 the same flies were fed on Monkey No. 107 (an infected monkey) before being again fed on Monkey No. 129. Monkey No. 129 was bitten by seven of these.

On August 25, Monkey No. 129 unfortunately died from peritonitis. No trace of *Micrococcus melitensis* was found in any of its organs, nor did its blood react.

Experiment 2.—Monkey No. 19, uninfected. Blood does not react. On August 25, 20 freshly caught flies were fed on this monkey. During the period between August 28 and September 15, 60 flies, which had been regularly fed on infected monkeys, were at intervals fed on this monkey. The animal has never shown any sign of reacting to *Micrococcus melitensis.*

Experiment 3.—Monkey No. 21, uninfected. Blood does not react. During the period between August 30 and September 7, 50 flies, which had been fed on infected monkeys, were thereafter fed on this monkey. The animal never showed signs of an agglutinative reaction, and died on September 22 (15 days after the last feeding) from peritonitis and tubercle of the lung. No *Micrococcus melitensis* was recovered from any of its organs at the *post-mortem* examination.

As the cooler weather approached it became increasingly difficult to obtain these flies in sufficient quantities for experimental work, and therefore further work is postponed.

Dissections.—Several of the flies were dissected out, and the various organs planted out on Petrie dishes, but no *Micrococcus melitensis* was recovered from any of these.

IX.—EXAMINATION OF ANIMALS IN CONNECTION WITH MEDITERRANEAN FEVER.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—THE EXAMINATION OF DOGS.

A series of 114 stray dogs, which had been seized by the police on the streets or in the suburbs of Valletta, Floriana, and Sliema, were examined. The animals were kept for 24 hours, in case they should be claimed by possible owners, and were then destroyed. Preparatory to their destruction, I examined their blood for an agglutinative reaction to the *Micrococcus melitensis*, and if a positive reaction were obtained, I made a *post-mortem* examination.

The agglutinative reaction was tried in dilutions of 1/10 and 1/30, with a time limit of half an hour. No sample was found to agglutinate beyond 1/30, unless it had stood for two hours.

The result was a positive reaction in 15 cases out of the total of 114, being a percentage of 13·15.

The following table gives at a glance the degree of reaction obtained. Each dog is described by a number which is placed in the column corresponding to the degree of the serum reaction.

	Reaction incomplete, 1/10.	Reaction complete, 1/10.	Reaction complete, 1/30.
Dogs by numbers	16	3	35
	23	11	44
	47 (no *post-mortem*)	73	107
	76	90	
	83	101	
	111	103	
Total	6	6	3 = 15

The degree of reaction is in no instance high, and but for the result of the *post-mortem* examination might very well be ignored.

Of the 15 dogs noted in the table, 14 were examined *post-mortem*. The routine adopted was to make cultivations on Petrie dishes from the following organs :—the spleen, the liver, the mesenteric, femoral, and axillary glands, and the urine ; broth cultures were also made from the heart's blood.

The result was that the *Micrococcus melitensis* was recovered in only one instance ; this was from No. 44, whose blood reacted up to 1/30

dilution, but did not go further. No. 44 was a dark brown short-haired bitch of Maltese breed, well advanced in pregnancy. Cultures on plates were made from the spleen, the liver, the mesenteric and femoral glands, and the urine. *Micrococcus melitensis* was recovered only from two plates made from the mesenteric glands. All the other organs were sterile and contained no micrococcus. The spleen was most carefully examined, practically the whole of the organ was cut into thin slices and smeared on six large Petrie dishes. The two plates made from the mesenteric glands contained respectively one and 34 colonies of *Micrococcus melitensis.**

Summary.—None of the 114 dogs had the disease in an acute form.

One dog contained *Micrococcus melitensis* in its mesenteric glands.

At least nine (omitting the six with an incomplete reaction) showed unmistakable signs of infection—a percentage of 8.

Conclusions.—Sufficient proof is here presented that dogs become infected by the microbe of Mediterranean Fever. Although I have not happened to come across one with the disease in an acute form, and have not been able so far to demonstrate the presence of the *Micrococcus melitensis* in the excretions, still there is no reason to suppose that infected dogs do not excrete the microbe in their urine as do other infected animals. The importance of this source as another cause of infection will be readily recognised, and in this connection it is interesting to note that 3410 stray dogs were seized and destroyed by the police during last year in Malta alone.†

I am informed by Mr. Curmi, the Superintendent of Police, that the total number of dogs in Malta and Gozo is at least 40,000.

II.—Preliminary Note on Mules and Maltese Stable Employés.

With the kind permission of Colonel Winter, Director of Supplies and Transport, I was enabled to examine the blood of 87 mules belonging to Government and used for transport purposes. The animals are not Maltese bred and have been in Malta for periods varying from 6 months to 10 years. They are groomed and driven by Maltese carters, and all the stable-hands are Maltese.

Those which I examined were quartered in three different stables:—

St. James's Ditch, Valletta.
San Marco, Valletta.
St. Paul's, Cottonera.

* Though it may be merely a coincidence that *Micrococcus melitensis* was recovered only from the mesenteric glands, it suggests that the infection had entered by way of the alimentary tract.

† Police Report, Malta, 1904–05.

St. James's Ditch Stables are the more modern and more sanitary buildings, well ventilated and airy, and are situated just outside the walls of Valletta.

San Marco Stables, standing in a low and thickly-populated part of the town, are poorly ventilated, shut in on all sides, and damp.

St. Paul's Stables are situated in the high ramparts of St. John's Bastion, in Cottonera lines. They overlook a slope thick with prickly pear, there is also a deep well just outside. The place is said to be infested with mosquitoes in the summer time.

I am informed that with the exception of some influenza and simple fever very little sickness occurs amongst the mules. In appearance the animals are sleek and in good condition.

On my first visit to the stables one of the mules which I examined (No. 42,290) gave a negative serum-reaction. On my second visit 12 days afterwards I was informed that this animal was on the sick list with slight fever, and had been off duty for a few days, but was returning to work next day. I therefore examined its blood again, and obtained a complete agglutination of *Micrococcus melitensis* in a dilution of 1/10, it did not, however, agglutinate in 1/20. This mule was undoubtedly suffering from a slight attack of Mediterranean Fever.

I have now (2 months later) examined its blood again, and find that it reacts completely in 1/10 and incompletely in 1/20 in half an hour. In the absence of any other means of proving the presence of the disease among these mules this was a very opportune case.

The following table gives the number of mules examined according to their service in Malta, and the stables in which they were quartered :—

Table A.

Service in Malta.	Quartered in stables at—			Total number examined.
	St. James's Ditch.	San Marco.	Cottonera.	
Under 1 year ...	6	—	—	6
1— 2 years......	9	28	—	37
2— 3 „	2	—	1	3
3— 4 „	1	—	1	2
4— 5 „	1	—	1	2
5— 6 „	3	—	4	7
6— 7 „	9	1	6	16
7— 8 „	3	—	4	7
8— 9 „	1	—	3	4
9—10 „	2	—	1	3
Total	37	29	21	87

Each sample of blood was examined in dilutions of 1/10 to 1/50, with a time limit of half an hour. A reaction was obtained in 39 cases, or 44·8 per cent., and the following table (B) gives these worked out to their highest dilutions:—

Table B.

Dilutions ...	1/10.	1/20.		1/30.		1/40.	Total.
		In-complete.	Complete.	In-complete.	Complete.	In-complete.	
Number of mules which reacted	23	6	6	2	—	2	39

I was enabled, through the courtesy of Mr. Macfarlane, M.R.C.V.S., to make *post-mortem* examinations of three mules which had to be destroyed on account of age and unfitness. I had previously examined samples of their blood, and found that one (No. 43,013) reacted in dilution 1/20, another incompletely in 1/10, and the third not at all. Cultures were made from the spleen, the mesenteric and femoral glands, and also, in the case of No. 43,013, from the liver. In every case these organs contained no *Micrococcus melitensis*.

To assist in arriving at some conclusions from these observations I drew up the facts in tabular form as follows:—

Table C.—Number of Infected Mules by Service in Malta.

	Under 1 yr.	1–2 yrs.	2–3 yrs.	3–4 yrs.	4–5 yrs.	5–6 yrs.	6–7 yrs.	7–8 yrs.	8–9 yrs.	9–10 yrs.	Total.
Number of mules examined	6	37	3	2	2	7	16	7	4	3	87
Number which reacted	1	21	2	1	1	4	5	3	1	0	39

Table D.—Number of Infected Mules according to Stables.

	St. James's Ditch.	San Marco.	Cottonera.	Total.
Number of mules examined	37	29	21	87
Number which reacted	10	15	14	39
Percentage...	27	51·7	66·6	

Table E.—Number of Infected Mules of less than Two Years' Service, according to their Stables.

Mules under 2 years' service.	St. James's Ditch.	San Marco.	Cottonera.	Total.
Number examined	15	28	—	43
Number which reacted	7	15	—	22
Percentage...	46·6	53·5	—	51·1

A study of these tables suggests the following observations:—

(1) Mules of less than two years' service show a slightly larger proportion of infected cases than those of more than two years' service. This difference becomes much more marked as the reactions in the lower dilutions are eliminated, as shown in the next table (F). For the purposes of this comparison it is convenient that half the total number examined were under, and the other half over, two years' service.

Table F.

Number of mules.	Service in Malta.		Total.
	Under 2 years.	Over 2 years.	
Examined	43	44	87
Reacted in 1/10	22	17	39
,, 1/20	7	3	10
,, 1/30	4	—	4

It will be seen that none of more than two years' service reached the 1/30 dilution, while only three out of a total of 10 reached 1/20. This points to a more severe or more recent infection among the later arrivals in the island.

(2) The stables at San Marco and at Cottonera show a larger proportion of infected animals than those in the Ditch. This, in the case of San Marco, is, I think, more apparent than real, for this reason, that most of the mules of less than two years' service are quartered there. When the two stables (San Marco and the Ditch) are compared by mules of the same length of service, the difference almost disappears. At the Ditch there were 7 infected out of 15 examined = 46·6 per cent. At San Marco 15 out of 28 = 53·5 per cent.

At Cottonera all the mules are of more than two years' service, and comparing them with those of the same service at the Ditch, we find that the larger proportion of infected cases at Cottonera is undoubted. At the Ditch there were 3 infected out of 22 examined = 13·6 per cent.; and at Cottonera 14 out of 21 = 66·6 per cent. There are therefore in proportion four times more infected mules in Cottonera than in the Ditch or in San Marco.

Summary.—Blood serum reaction to *Micrococcus melitensis* was obtained in 44·8 per cent. mules examined. In one case the appearance of the serum reaction was coincident with a slight attack of fever The serum reaction obtained was in every case rather low, only two reaching 1/40.* The highest reactions were obtained in those of under two years' service in Malta. In proportion there were four times more infected mules in Cottonera than in the Valletta stables.

Conclusions.—Mules are exposed to and suffer in a mild way from infection by *Micrococcus melitensis.* I reserve other remarks until further investigation has been carried out.

The Maltese Stable Employés.

The examination of those employed in the stables was a natural sequel to the examination of the mules. They are all Maltese, who have been employed with the Army Service Corps for periods varying between 20 years and 20 months: a good many new hands were taken on 20 months ago, and of these I examined 33. The total number examined was 80. I have divided them into two classes according to their employment.

(1) *Carters.*—These men drive the mules and spend most of their day on the road. They also groom their mules and spend one night in 8 or 9 on stable guard, when they remain on duty in the stables all night. On other nights they sleep at their respective homes.

(2) *Stable-keepers or Labourers.*—These men are the sweepers and general labourers in the stables; they spend practically the whole day in and about the stables, and on one night in every three they sleep there.

The result of the examination of the blood of these men for a reaction to *Micrococcus melitensis* was as follows:—

1. *Carters.*—The total number examined was 73, and of these 30 had been only 20 months in the service. Four gave a reaction; two in 1/30 and two in 1/10 dilutions. Their particulars are as follows—

   No. 80.—Reacted 1/30; 13 years employed; says that he had fever lasting 2 months 3 years ago, and that he is in good health now. Temperature when examined 99°·6.

* To compare low serum reaction in animals, *vide* Report on Malta Fever in Dogs, *ante* p. 84.

No. 121.—Reacts 1/30; 20 months employed; was sick with fever and pains in head 4 months ago.

No. 112.—Reacted 1/10; 20 months employed; had fever lasting 18 days 4 years ago; is in good health now.

No. 114.—Reacted 1/10; 14 months employed at Cottonera; says that he has never been sick except for pains in the head during the summer. Temperature normal.

Besides these cases, faint reactions were obtained in 3 others who had a history of fever many years ago, they were all old hands.

Nos. 80 and 121 are the only ones out of the above 4 that can definitely be said to have contracted fever whilst employed in the A.S.C. stables; and No. 121 is the only one out of 30 with 20 months' service who has taken the disease.

2. *Stable-keepers.*—The total number examined was 7, and of these 3 had 20 months' service. Two reacted. Their particulars are—

S. A——.—Reacted in 1/30; 20 months employed; fell sick at San Marco Stables in the beginning of the summer and was ill for 4 months.

S. V——.—Reacted in 1/10; 6 years employed; had fever some years ago.

Both these stablemen contracted the disease whilst employed in the stables, and S. A—— is one of three who have only 20 months' service.

Summary.—Of a total of 80 men examined, 4 (= 5 per cent.) showed signs of a more or less recent infection and had contracted the disease whilst employed in the stables. Two were stablemen and 2 were carters, being 28 per cent. of stablemen as compared with 2·5 per cent. of carters. Two out of 33, or 6 per cent., contracted the disease within 20 months of starting work at the stables, one of them was a stable-keeper, being 1 in 3 stablemen as compared with 1 in 30 carters.

Conclusions.—These observations are suggestive of lines of future work, especially with regard to biting insects.

X.—BACTERIOLOGICAL EXAMINATIONS OF CASES OF MEDITERRANEAN FEVER.

By Captain J. CRAWFORD KENNEDY, R.A.M.C.

(Received December 16, 1905.)

I.—EXAMINATION OF SALIVA.

The cases examined were four in number, and were selected on account of their severity.

CASE A.—A very severe case with persistent and irregular fever, no normal temperature for 90 days; extreme anæmia. Samples of saliva were taken from this case on the following days of disease, 36th, 37th, 38th, 39th, 41st, 42nd, 68th, 69th, 70th, 71st, 72nd, 73rd, 74th, 75th, 76th, 77th, 83rd and 84th.

CASE B.—A moderately severe case with four well-marked "waves" of fever. The third wave was the most severe. Samples of saliva were collected on the following days of the disease, during the comparative apyrexial period between the 3rd and 4th "waves," the 58th, 59th, 60th, 61st, 63rd and 64th days.

CASE C.—A severe case with marked anæmia. First "wave" severe, prolonged, lasting 30 days. Second "wave" very acute, lasting 21 days. Samples of saliva collected in the period between the 1st and 2nd "waves" on the following days of disease, the 42nd, 43rd, 44th, 45th, 47th and 48th.

CASE D.—First "wave" ran a regular course, with little constitutional disturbance, though temperature was high; it lasted 34 days. The samples of saliva were collected on the 38th and 39th days of disease during the apyrexial period before the second "wave."

Method of Collecting the Saliva.—It was attempted to collect the saliva as it escaped from the orifices of the ducts, but, on account of the inconvenience caused to the patients, this was not peristed in. The patient was therefore asked to spit into a sterile test-tube after his mouth had been well cleansed by means of a tooth brush and carbolic powder and well rinsed with a solution of boracic acid.

Method of Examination.—The saliva, being loaded with contaminating organisms, and, in especial, with acid producing *Streptococci*, requires to be greatly diluted before its culture on plates could be attempted with any chance of success. Two or three methods were tried, but the following was finally adopted :—

Four or five test-tubes, each containing 10 c.c. of distilled water, were sterilised and labelled respectively A, B, C, D, E. To A was added 1 c.c. of the saliva; to B 1 c.c. of the mixture in A; to C 1 c.c. of the mixture in B, and so on. The diluted saliva was then planted

out on Petrie dishes containing the nutrose litmus agar, 1 c.c. from each tube being distributed over four plates.

After incubation for four days the plates made from tubes A and B were, as a rule, found to be crowded with acid colonies, and quite useless. The higher dilutions gave very clean plates; 298 plates were thus examined, but *Micrococcus melitensis* was not recovered.

Result.—In 32 samples of saliva from Mediterranean Fever patients in varying stages of the disease, no *Micrococcus melitensis* was found.

II.—*Post-mortem* EXAMINATION OF FATAL CASES OF MEDITERRANEAN FEVER.

During the year 1905 a more or less systematic *post-mortem* examination of fatal cases has been carried out in order to obtain some idea of the distribution of the *Micrococcus melitensis* in the human body. A series of nine cases has been collected and to these I have added four others which occurred in the previous year. A number of these have been examined in conjunction with Major Horrocks. My observations and remarks are recorded concisely under the headings of the various organs, and the accompanying table will show at a glance the proportion of recoveries of *Micrococcus melitensis* from each organ.

Spleen and Liver.—These organs invariably contain *Micrococcus melitensis* in large quantities during the febrile stage.

Kidney.—The organism is not so abundant here and in one case was not obtained.

Bile.—Eight samples were cultured, and from two *Micrococcus melitensis* was recovered in pure culture, but in no great quantity.

Bile Duct and Bladder.—Scrapings were made from the walls in two instances. No recovery of the microbe was made.

Urine.—Last year, when the urine investigation was being carried on, three samples were taken from the bladder: one sample contained the microbe. This was the second occasion on which *Micrococcus melitensis* was found in the urine.

Intestines.—These were examined in four cases, and several hundred plates were made from scrapings from the walls or from the contents of the duodenum jejunum, ileum, and colon. The specific microbe was not detected, although it must be present, seeing that it occurs in the bile, but it evidently does not multiply in the intestines.

Bone marrow was examined in four cases. Recoveries of the microbe were made in two of these. In one of them the colonies of *Micrococcus* were very profuse.

Heart's Blood.—Cultures were made in four instances, two of which yielded the microbe. One of the unsuccessful cases was a chronic one of a month and a half's duration; in the other only a very small quantity of blood was used.

Pericardial Fluid.—In one case out of two *Micrococcus melitensis* was recovered; this was one which had lasted for a month and a half.

Pleural Fluid.—One case was examined; result, negative.

Cerebro-Spinal Fluid.—This was examined in two cases with marked meningeal symptoms. The fluid was much increased in quantity and had caused a good deal of flattening of the cerebral convolutions. Great difficulty was experienced in keeping it free from contaminations. No *Micrococcus melitensis* was recovered.

Lymphatic Glands.—A distinct advance has been made by the discovery that the lympathic glands are great receptacles for the *Micrococcus.* In one of my later cases I was struck by the size and appearance of the mesenteric glands. They were similar to what are found in enteric fever—the size of a large marble, fluid in the centre and the capsule injected. On being cut, they were found to contain what was to all appearance pus. A loopful of this fluid was spread over several Petrie dishes containing the usual nutrient medium, and after incubating for four days a pure growth of *Micrococcus melitensis* resulted, so profuse as to cover every part of the plate that had been touched by the platinum wire. After this discovery the glands from other parts of the body were examined and also found to contain microbes in great quantity. In one case the glands from the axilla groin, mesentery, carotid and mediastinum were examined, but only from the mediastinal was the microbe obtained. In another case where the femoral, thoracic and mesenteric glands were examined, the microbe was present in the femoral and thoracic, but not in the mesenteric.

This observation has been of the greatest value in the *post-mortem* examinations of experimental animals. In many cases they take the disease in a mild form, and the specific microbe soon dies out of the spleen, remaining, however, for a longer time in the glands. Therefore the routine practice at *post-mortem* examinations is to examine the femoral, axillary and mesenteric glands, as well as the other organs. Had this not been done many *post-mortem* examinations must have proved negative, seeing that the glands were the only organs which contained *Micrococcus melitensis.*

The following idea is suggested by the foregoing observations. If the mode of infection happen to be through a mucous membrane, *i.e.*, the alimentary canal, the glands draining that area offer a good nidus for the multiplication of the *Micrococcus melitensis*, and in time form a good focus from which the whole system becomes infected. I think that many cases with long incubation periods might be explained in this way: For instance, a common type of the disease is manifested as follows:—

First, a slight attack of fever, labelled, for want of a better term, S.C. Fever, lasting two, three, or four days, with no agglutinative reaction in the blood. This probably coincides with the local invasion.

Second, a period of quiescence lasting three weeks to a month or longer, the period of incubation.

Third, sharp attack of high fever, with no appreciable enlargement of the spleen till the third or fourth day. This marks the systemic invasion and the full development of the disease.

Tonsils.—In view of the glandular character of these organs and a possible entrance for infection, four cases were examined, but no *Micrococcus melitensis* was isolated.

Salivary Glands.—Concurrently with the examination of the saliva, two cases were examined *post-mortem*, but without the recovery of the microbe.

Table and Summary.

Organ.	Number of times examined.	Number of times *Micrococcus melitensis* recovered.
Spleen	13	13 = 100 p. c.
Liver	3	3 = 100 ,,
Kidney	7	6 = 85 ,,
Urine	3	1
Lymphatic glands	5	5 = 100 ,,
Mediastinal	1	1
Thoracic	1	1
Mesenteric	5	3
Femoral	3	2
Axillary	1	0
Carotid	1	0
Heart's blood	4	2
Pericardial fluid	2	1
Bone marrow	4	2
Bile	8	2
Bile duct and bladder	2	0
Intestines	4	0
Duodenum	4	0
Jejunum	3	0
Ileum	3	0
Colon	1	0
Salivary glands	2	0
Tonsils	4	0
Pleural fluid	1	0
Cerebro-spinal fluid	2	0

XI.—AN EXAMINATION OF GOATS IN MALTA, WITH A VIEW TO ASCERTAIN TO WHAT EXTENT THEY ARE INFECTED WITH MEDITERRANEAN FEVER.

By Dr. T. Zammit.

(Received December 18, 1905.)

I.—Attempts to Recover *Micrococcus melitensis* from Goats Slaughtered at the Civil Abattoir.

As soon as goats were suspected to be liable to the infection of Mediterranean Fever, an examination of the animals slaughtered at the civil abattoir was undertaken. None of the animals had been previously selected or examined, and some of them turned out to be male Barbary goats which had been brought to Malta to be fattened and sold as mutton. When a goat was killed a capillary tube was filled with blood for the serum test, and the spleen was carefully removed and taken to the laboratory for examination; 46 goats were thus examined, and the microbe was recovered in one case only. The serum reaction showed, however, that more than one goat had at some time been suffering from Mediterranean Fever, for seven of the bloods gave a clear positive reaction with *Micrococcus melitensis* at a dilution of at least 1 in 80. All the goats appeared to be in good condition, and were passed for consumption by the veterinary surgeon of the abattoir.

II.—*Post-mortem* Examination of Goats bought in June, 1904.

The goats bought by us in June, 1904, and found to be suffering from Mediterranean Fever, were slaughtered in September, 1905. Of six animals, numbered one to six, No. 4 never gave a reaction for Mediterranean Fever, and was therefore used for other experiments. No. 3 always reacted strongly after it was sent to the Lazaretto. In July, 1905, it lost flesh, and on August 2, being in a dying condition, it was killed and carefully examined. A large number of broth and agar tubes were inoculated with material taken from all the organs, but the *Micrococcus melitensis* was not recovered. Nos. 1, 2, 5, 6 appeared quite healthy. They were slaughtered between September 25 and 29. The animals were in perfect condition, very fat, and with all the organs apparently healthy.

A great number of culture tubes were used for the examination, and, fortunately so, for if fewer had been used it is probable that the microbe would have escaped notice in some of the cases. The *Micrococcus melitensis* was recovered from all the goats except from No. 2. During life this micro-organism had only been obtained from the blood of Nos. 5 and 6, but on the other hand it had been recovered from the

urine and milk of all four goats. At the *post-mortem* examination the microbe appeared to be irregularly distributed in the body and in rather small numbers.

In No. 1 it was obtained from the spleen and the kidneys, but in small quantities. In No. 5 it was recovered from the kidneys only. In No. 6 it was only found in the glands.

Other goats (Nos. 15, 16, 17, 18), affected with Mediterranean Fever, were slaughtered in September. The *Micrococcus melitensis* was recovered from all except from No. 18. In No. 15 it was obtained abundantly from the kidneys. In Nos. 16 and 17 only a few colonies were procured from the lymphatic glands.

The serum reaction remained positive and constant in all the bloods, though in some of them it became very weak, not higher than 1 in 40.

The *Micrococcus melitensis* in infected goats tends to disappear from the system after a time, but the process is slow.

Our goats having been bought in June, 1904, already infected, we could not ascertain how long they might have been in that condition, but it is a fact that after 15 months the specific micro-organism was still living in their lymphatic glands.

III. Recovery of *Micrococcus melitensis* from the Blood of Goats.

In certain phases of the disease the specific microbe circulates freely in the blood, and it can then be easily recovered. This condition does not seem, however, to last long, since a blood which yields the microbe one day, will not show any after the lapse of a week. About 5 c.c. of blood were taken from the jugular vein of goats 32 times. The same animal was sometimes tried three or four times. The blood was distributed in 20 c.c. broth tubes and incubated. The *Micrococcus* was only recovered from four goats (Nos. 5, 6, 21, and 29). The animals had all contracted the disease before they were obtained, and as when brought to us they already displayed a strong serum reaction, no idea could be formed as to the stage of the disease at which they had then arrived. Some of the cases were undoubtedly of long standing.

IV. The Reaction of Goat's Milk to the *Micrococcus melitensis.*

On July 10, 1905, I observed that the agglutination test could be applied to the milk of goats affected by Mediterranean Fever as well as to the blood. At a point in our investigations it had become difficult to obtain samples of blood from goats, as the owners strongly objected to have their animals bled. The use of milk instead of blood for the specific reaction proved a great help and enabled us to examine a large number of goats.

The test can be applied on a slide in the ordinary way or in capillary pipettes as in the method of precipitation. In time, however, the precipitation method was adopted as being more conclusive and easier to work, especially when a great number of samples had to be dealt with.

The only precaution to be taken in applying the test is the addition of an antiseptic, strong enough to prevent the clotting of the milk, but without affecting in any way the agglutinins. For the examination of a large number of samples the following method was found to answer best:—

A strong emulsion of the *Micrococcus melitensis* is prepared in normal saline solution in a watch-glass. To this a small quantity of formaldehyde solution is added (one small loopful of a 1-per-cent. solution), the whole being drawn into a pipette. One drop of the emulsion is placed on a glass slide and a loopful of milk is mixed thoroughly into it. This mixture is then drawn up into a fine capillary pipette, left in an upright position for 12 hours, and the reaction noted at the end of that time. The reaction is often seen after a few minutes. The cream collects at the surface and does not interfere with the reaction.

Between July 10 and September 22, 1905, 710 samples of milk were examined and a positive reaction was obtained 133 times.

With a view to check the value of this method all the milks that showed a positive reaction were tested a second time. Further, where possible, blood was obtained from the animal for the serum test, and the suspected milk was plated out.

The blood test constantly confirmed the milk test, and when a strong reaction was obtained the specific microbe was always recovered from the milk. In conclusion, in my opinion, the milk test is a safe one and quite as reliable as the blood test. For sanitary purposes, more especially where a great number of goats have to be examined, the milk test is at once convenient and efficient.

V. The Milk Test as applied to Goats in the Country.

As soon as the susceptibility of the goat to Mediterranean Fever had been established it became obviously desirable to ascertain how far herds which supplied milk to the towns and villages were affected. In July, 1905, we heard from one of the district medical officers that cases of the fever were numerous in two villages, Lia and Balzan, whereas few or none were reported from the neighbouring village of Attard. These three villages form a group lying close together about the centre of the island.

It was decided, therefore, to examine the herds of this group of villages first and then work in other directions according to circumstances. Every village has a number of herds, but many goats are

distributed singly, every family, as a rule, keeping a goat for its own use. I have arranged the result of the examination in the following tabular form :—

Name of village.	Street.	Number of goats in herd.	Number of goats which reacted.	Remarks.
Lia	Molino Musta	15	None	
,, ...	Forni, 12	7	2	
,, ...	,, 24	4	None	
,, ...	Concezione..................	9	,,	
,, ...	Molino, 28	5	,,	
,, ...	Preziosi	13	,,	
,, ...	Concezione..................	11	,,	
,, ...	Reale, 9	1	,,	
,, ...	,, 128..................	2	,,	
,, ...	Stretta Enea, 2	1	,,	
,, ...	,, 3	6	,,	
,, ...	Concezione, 33	1	,,	
,, ...	,, Vlo, 3°	2	1	*Micrococcus melitensis* recovered. Case of Mediterranean Fever on the premises.
,, ...	,, 28	4	None	
,, ...	Forni, 54	1	,,	
,, ...	,, 42	1	,,	
,, ...	S. Andrea, 15	1	,,	
,, ...	No address..................	4	2	Goats were being taken to Mosta.
,, ...	Reale, 82......................	12	7	
Balzan......	Reale, Vlo, 2°	18	6	The *Micrococcus* recovered from 3. 2 cases of Mediterranean Fever on the premises during the last twelvemonth.
,, ...	Provvidenza Vlo, 2°	20	2	
,, ...	,, Vlo, 3°	7	None	
,, ...	,, Vlo, 2°	17	3	
,, ...	,, ...	16	2	
,, ...	3 Chiese, 25	18	2	
,, ...	,, 9	1	None	
,, ...	,, 33	1	1	
,, ...	Itmeida, 16..................	1	1	Case of Mediterranean Fever on the premises.
,, ...	No address..................	3	2*	
Attard......	Via C. Cormi, 22	5	None	
,, ...	,, 2	2	,,	*Goats were being taken to Mosta.
,, ...	Via Notabile, 3............	7	,,	
,, ...	Reale, 24	2	,,	
,, ...	Lunatic Asylum	31	,,	
,, ...	Molino Vlo, 1°	4	,,	
,, ...	,, 14............	5	,,	
,, ...	S. Domenico, 19	6	,,	
Zeitun......	Herba, 16	8	,,	
,, ...	Giardino Botanico, 10 ...	10	,,	
,, ...	Vlo Privato, 3	6	,,	
,, ...	Piazza Maggiore, 44......	12	,,	
,, ...	Madonna Pietà, 119	11	1	
,, ...	Giardino B..................	11	1	
,, ...	Herba, 26	8	None	
,, ...	Sciortino, 22	11	,,	
,, ...	S. Giovanni	5	1	
,, ...	Sta Maria...	5	None	
,, ...	Marsascirocco, 11	5	1	
,, ...	,, 11 (A.C.)	11	None	
Zabbar......	Xghira, 75	8	1	
,, ...	Marsascala, 22	8	None	

Name of village.	Street.	Number of goats in herd.	Number of goats which reacted.	Remarks.
Zabbar......	Marsascala, 6..............	18	5	*Micrococcus* recovered from 3.
"	Piazza S. Giacomo, 30 ...	11	1	
"	Sta Maria, 12..............	7	None	
"	Marsascala..................	13	3	
"	Vlo Hassajed	7	1	
"	Xghira, 72..................	5	3	
"	" 71..................	11	3	
"	S. Domenico, 1	4	1	
"	S. Giuseppe, 68	18	2	
"	Capuccini	14	1	
"	Marsascala..................	6	2	
"	"	14	9	
"	S. Domenico	10	7	
"	Tal Fgura	24	5	*Micrococcus* recovered from 2.
Hamrun ...	Dolori, 29	30	8	
" ...	Vlo Tal Fatati	18	11	
" ...	"	35	5	
Axiak	Via Gudja	10	2	
Curmi	S. Pietro......................	8	1	
Taxbiex ...	Via Sliema	5	None	

The principal herds of Lia, Balzan, Attard, Zeitun, and Zabbar were visited, and about one-half of the goats of those villages were tested. The percentage of infected animals is therefore practically accurate. It stands as 12 per cent. for Lia, 19 per cent. for Balzan, 0 per cent. for Attard, 4 per cent. for Zeitun, and 25 per cent. for Zabbar.

As to Hamrun, only three herds were gone through, and there are hundreds of goats in that village. The percentage of infected goats at this place cannot be deduced from our work, but the three herds examined were badly infected.

XII. A CRITICAL EXAMINATION OF THE BLOOD OF PATIENTS IN HOSPITAL, TO DETERMINE IF OTHER THAN MEDITERRANEAN FEVER SERA WOULD AGGLUTINATE THE *MICROCOCCUS MELITENSIS*.

By Fleet-Surgeon P. W. Bassett-Smith, R.N.

(Received January 11, 1906.)

The importance of placing beyond doubt the specific character of the agglutination of the *Micrococcus melitensis* when brought in contact with the blood serum of patients, cannot be over estimated, either when the test is used for diagnosis, or for controlling experimental work. There have been cases, from time to time, which have led certain diagnosticians to underrate this modern method of diagnosis. These people would therefore naturally discredit all investigations based on this principle, pointing to cases in which contradictory results have been obtained from the same serum, and to statements that a positive reaction for Mediterranean Fever has been met with in other diseases.

Bearing these facts in mind, I have made a careful examination of 150 samples of blood, taken systematically in the wards of Haslar Hospital, for the purpose, if possible, of demonstrating whether or not the serum of patients suffering from a great variety of diseases other than Mediterranean Fever would give a reaction likely to render a mistake in diagnosis probable. It is unnecessary to describe fully the technique employed, this being so well known, excepting to say that—

1. The tubes containing the blood were centrifugalised, and the clear serum was alone used.

2. The emulsion was made from an agar culture 10 days old of a strain of *Micrococcus melitensis* obtained in November, 1905, from the peripheral blood of a patient now in the hospital, and was used living.

3. The serum dilution of 1 in 30 was made with normal saline solution, using accurately graduated pipettes.

4. The examination was made both microscopically, with a 4-hour limit, and by sedimentation tubes with a 24-hour limit.

5. Controls were made for each batch of tubes, with a serum that reacted perfectly in dilutions from 1 in 30 to 1 in 1000.

The whole examinations were made by myself, but the readings were confirmed by independent observers.

The results are tabulated as follows:—

Nature of disease.	Number of cases tested.	Microscopical.	Sedimentation.
Enteric fever	3	Negative	Negative.
Tubercle of lung	12	,,	,,
,, testicle	1	,,	,,
,, joint	1	,,	,,
Tubercular empyema	1	,,	,,
Pneumonia	5	,,	,,
Bronchitis	2	,,	,,
Bright's disease	3	,,	,,
Hydronephrosis	1	,,	,,
Rheumatism	7	,,	,,
M.C.O.	7	,,	,,
Tonsilitis	3	,,	,,
Dilated stomach, etc.	1	Positive	Positive.
Lead paralysis	1	Negative	Negative.
Appendicitis	7	{ 2 Positive 5 Negative	{ 2 Positive. 5 Negative.
Hemiplegia	1	Negative	Negative.
Epilepsy	3	,,	,,
G.P.I.	1	,,	,,
Alcoholism	1	,,	,,
Aneurism	1	,,	,,
Abscess, local	7	,,	,,
,, liver	2	,,	,,
,, psoas	1	,,	,,
,, mastoid	6	,,	,,
Cellulitis	4	,,	,,
Septic thrombosis	1	,,	,,
Otorrhœa	2	,,	,,
Iritis	3	,,	,,
Keratitis	2	,,	,,
Synovitis	1	,,	,,
Herniotomy	5	,,	,,
Hæmorrhoids	1	,,	,,
Varicose veins	1	,,	,,
Ulcers	2	,,	,,
Fractures	10	,,	,,
Wounds	4	,,	,,
Eczema	4	,,	,,
Gonorrhœa	5	,,	,,
Gon. rheumatism	2	,,	,,
Syphilis 1	16	,,	,,
,, 2	7	,,	,,
Normal blood	2	{ 1 Positive 1 Negative	{ 1 Positive. 1 Negative.
Totals	150	{ 4 Positive 146 Negative	{ 4 Positive. 146 Negative.

It will be seen that the blood of 41 pathological conditions was tested, and that, in all but four cases there was no evidence of agglutination of the *Micrococcus melitensis*. Of these four positive reactions, two appendicitis cases had lately returned from Malta Hospital, and were running a regular undulant temperature, and had undoubted

Mediterranean Fever. The third case was a sick berth steward, who had Mediterranean Fever two years and 10 months ago. The fourth was a long time in Malta Hospital, where gastroduodenostomy was performed, and, though there is no definite temperature chart of Mediterranean Fever, I have no doubt that he was, like so many others, infected by the micro-organism there. His temperature is now irregular.

All these examinations, therefore, gave an *absolute negative* to other than Mediterranean Fever blood causing agglutination of the *Micrococcus melitensis* in a dilution of 1 in 30. The following points were also investigated with regard to this reaction :—

Will Lower Dilutions give Erroneous Results?—Ten of the already-used samples of blood were tested in dilutions of 1 in 5, 1 in 10, and 1 in 20. In one case only was there any reaction, an abscess of the knee, which agglutinated up 1 in 10.

Are the Agglutinating Properties Destroyed by Keeping the Blood?—Some serum from a tube of blood, which had been taken from a patient in November, 1901, was tested in the same manner.

	Dilution.			
	1/10.	1/20.	1/40.	1/200.
Microscopic	+	+	+	+
Sedimentation	+	+	+	+
Control, normal blood...	—	—	—	—

Result.—Four-year old blood serum agglutinated perfectly.

Are the Agglutinating Properties Destroyed by Heat?—A portion of the control-serum was heated to 60° C. for 10 minutes, and tested as before.

Result.—A good reaction, both microscopically and in sedimentation tubes, at 1 in 30 was obtained.

Are Dead Cultures Reliable for any Length of Time?—Using the control-serum, the following dead emulsions made in the laboratory were tested, dilution 1 in 30.

	Micro-scopical.	Sedi-mentation.
1. Agar emulsion of *Micrococcus melitensis* isolated at Haslar, heated to 65° for quarter of an hour, 0·5 per cent. formalin. Made 9.11.03	+	+
2. Agar emulsion from strain, given by Professor Wright, Netley. Made 8.11.04	+	+
3. Agar emulsion, from Haslar strain 2. Made 20.3.05	+	+
Control, normal blood	–	–

Thus, dead cultures made here more than two years ago were perfectly reliable, though the reaction is less rapid than when living ones are used.

Reliability of the Agglutination Reaction in Mediterranean Fever.—Here it may be stated at once, that in acute cases, I have found the reaction unmistakable, the serum in fairly high dilutions, acting on the *Micrococcus melitensis* almost immediately, clumping completely, and being generally easily visible with a 1-inch objective. With chronic cachectic cases of more than four months' duration, so commonly met with in Haslar Hospital, it is different, the reaction being often incomplete, slow, and only obtainable in very low dilutions, as shown by the following cases :—

1. J. W. Onset of the fever, April, 1904 ; returned to the Mediterranean in 1905 : immediate relapse. In November, 1905, the blood only agglutinated in dilutions of 1/10, yet the *Micrococcus melitensis* was in the same month isolated from his blood.

2. J. P. Onset April 19, 1905 ; now intense emaciation and neuritis. In November the blood agglutinated up to 1/10 ; with 1/5 the reaction was immediate.

3. T. S. Onset August, 1905 ; great emaciation and neuritis. In November the blood only reacted up to 1/10.

From these results, and from a great number of the same kind, I have formed the opinion that, when using the 1/30 dilution (if the technique is properly carried out), a positive agglutination reaction may be considered conclusive of Mediterranean Fever, past or present. On the other hand, it would not be correct to state that the patient is not suffering from Mediterranean Fever, when an examination of the blood gives a negative reaction with this dilution. I believe the chief sources of fallacy are—

1. Faulty technique ; incorrect dilutions, too long time, etc.
2. Faulty cultures ; containing false clumps before use, etc.
3. Faulty observations ; mistaking false clumps for true agglutination.
4. Faulty history ; the patient having previously had the disease.

The sedimentation test appears to me to be the least likely to give rise to errors, provided *clear* blood serum is used, and the emulsion be sufficiently strong to give a visible pellet at the bottom of the tube.

XIII. — REPORT ON THE PREVALENCE OF MEDITERRANEAN FEVER AMONGST BRITISH TROOPS IN MALTA, 1905.

By Lt.-Col. A. M. Davies, R.A.M.C., Member Mediterranean Fever Commission.

Introductory.

On taking up the investigation of Mediterranean Fever in its epidemiological aspects, at the beginning of June, 1905, after consideration of the various lines on which such an inquiry might be best carried out, I became convinced that the most profitable course to adopt would be to devote the greater part of the time at my disposal to the study of the disease as it manifested itself amongst the British troops. Dr. R. W. Johnstone having made a general survey of the circumstances in regard to the whole population, civil, naval and military, up to the time of writing in the previous year, it seemed that a more detailed consideration of one branch of the subject—even though in numerical importance only a small one—might lead to useful results. I was the more inclined to take this course for two reasons: first, Dr. Johnstone had made such a comprehensive survey of the "sanitary circumstances and prevalence of Mediterranean Fever" in the previous year, that there was no need for another inquirer to go over the same ground a few months later; and, secondly, the fact that, in regard to the military population the statistical data—which are the foundations of an epidemiological inquiry—are to be relied on almost implicitly; while in regard to the population of Malta generally, our knowledge of the actual distribution of the disease, both in place and time, is at present so very imperfect, that the difficulties in the way of discovering the causative factors are extreme. Dr. Johnstone has mentioned this in his Report (p. 11). The notification of Mediterranean Fever throughout the population generally is extremely inaccurate, "only severe cases are notified, and not always these." Now, whether in regard to differences of prevalence in different *places*, or variation in incidence at different *times*, unless there is good ground for trusting to the accuracy of the records of prevalence (*i.e.*, the notifications), the labour expended on inquiring into apparent outbreaks may be entirely thrown away.

The military population concerned is approximately 9000; if every case of Mediterranean Fever occurring in this population during even a single season were accurately recorded as to time and place of onset, and as to all the surrounding circumstances that could be

regarded as bearing on the problem, a body of facts ought to be forthcoming that would at any rate make some addition to our knowledge of the causation of the disease; if not of the actual cause, at least of the conditions favouring the effectual operation of the cause. There seemed to be every likelihood, from the behaviour of the epidemic in May, that a large number of cases would occur amongst the troops during the hot season; and that the amount of material for investigation would be large enough to make it justifiable to limit the inquiry to this particular line. From January 1 until September 30, 1905, there occurred 487 admissions for Mediterranean Fever from among the British troops, and it is to the study of this epidemic that I have chiefly given attention.

Three principal lines of investigation presented themselves: (1) It appeared to be necessary to make a detailed sanitary survey of the actual conditions under which the troops are living in the various barracks in the Maltese Command: I accordingly visited repeatedly every individual barrack, and examined into its situation, construction, water supply and drainage, as well as any other matters that seemed to need investigation. In the present state of our knowledge, or want of knowledge, as to the causation of Mediterranean Fever, it did not seem allowable to neglect any point of general sanitary importance, even though its connexion with the prevalence of this disease did not seem to be obvious. It does not, however, appear necessary to encumber this report with all the detailed results of this investigation, referring in many instances to somewhat minute points of sanitary engineering practice or military administrative procedure; a brief summary only of the more important points is set forth in *Section I*, the details forming a separate Report presented to the Director-General, Army Medical Services.

(2) Concurrently with this the course of the epidemic was noted, and as far as possible inquired into at the time, and on the spot, week by week; the intention being to record, as accurately as might be, the actual incidence of the disease in the various barracks and in the various regiments. As far as I have been able to ascertain, it has hitherto been the practice to allocate the cases of Mediterranean Fever to the barracks from which they have been admitted; the object of this part of the special inquiry has been to trace the origin of these cases with greater exactness, ascertaining the movements of the patient previous to admission to hospital, and endeavouring to locate not merely the barrack, but the room, which he had been occupying for some time before admission. In this way it was hoped that some facts would be ascertained that would serve as indications as to the cause, or rather the mode of spread, of the disease. These results are summarised in *Section II* of this Report.

(3) As another means to the same end, the attempt was made to

interview personally every Mediterranean Fever patient, and elicit all the information procurable as to his habits, occupations and so on previous to being taken ill. Unfortunately some patients were too ill to be questioned, some were invalided before I was able to visit them; so that from one cause or another not more than 187 were actually interviewed. I much regret that I was not able to carry this part of the inquiry further.

The information obtained by these three lines of inquiry is summarised in *Section III*, in which an attempt is made to correlate the various facts, and ascertain what relation exists, if any, between Mediterranean Fever prevalence and this or that sanitary condition. The conclusions arrived at, and certain recommendations submitted, are set down in *Section IV*.

Incubation Period.—A great difficulty, that has been experienced by all inquirers into the epidemiology of Mediterranean Fever, arises from the uncertainty that exists as to the length of the incubation period. Hughes, from his own experience, and from a study of the literature of the subject up to the time of writing (1897), considered that it might be "as short as three days in some cases. Probably 3 to 10 or 15 days is near the mark in cases where the first febrile onset is noted." Dr. Johnstone states that "the general impression amongst Maltese medical men seems to be that the usual incubation period is not more than 8 or 10 days." In five laboratory cases of human infection "in places where there was no prevalence of Mediterranean Fever, and no apparent source of infection other than in relation with infective material in the laboratory," the periods were respectively 5, 6, 8, 15 and 16 days. These infections appear to have all been by inoculation; all were accidental, except the one with 16 days incubation, which was definite and purposeful. In the previous Reports of the Commission instances are recorded of infection by inoculation manifesting itself after 5 and 8 days in monkeys (Gilmour), after 6 days in goats (Shaw), after 6, 10 and 13 days in monkeys (Horrocks); in all these cases the agglutination test has been taken as the proof of infection. By the same test infection by feeding has been demonstratnd in monkeys after about 24 to 32 days in several cases (Horrocks), and in one case, in a goat, apparently after 21 days (Horrocks). There is a sufficient agreement in these results to lead to the supposition (which is on other grounds reasonable) that with infection by inoculation the incubation period is shorter than by ingestion into the alimentary canal; with inhalation of infected dust (monkeys) the incubation period is uncertain, 17 to 31 days or less (Horrocks).

How far the period of incubation observed in animal experiments can be considered to hold good in the case of man is doubtful; the doses used in the laboratory have been enormous; and as it would be

unreasonable to suppose that the quantitative element has no effect on the rapidity of development of the disease, the laboratory limits in all probability require to be considerably extended when the question of human infection in the ordinary way or ways has to be dealt with. As we are at present ignorant of the path of infection in man, we must assume that incubation may be as short as about a week, and may be as long as about five weeks, according as the infection is by inoculation or by feeding. But considering the very much smaller doses of pathogenic material likely to be actually absorbed than those used experimentally in the laboratory, it seems probable that not less than a fortnight should be regarded as a minimum period, and that the maximum period should be extended up to about six weeks at least.

In the absence of any more definite guidance I have adopted a fortnight as the most likely incubation period *at the least*, and a further fortnight as *probably* needful to be allowed, for incubation. That is to say, if a man moves from Barrack A to Barrack B, and subsequently develops Mediterranean Fever, I consider that if his illness commences within a fortnight of his change of residence, the infection was *almost certainly* contracted at A; while if it commences within a month of the move, it has *more probably* been contracted at A than at B. I have not been able to ascertain any shorter instances of incubation than the two quoted by Dr. Johnstone (*Report*, Part II, p. 15), of 8 and 11 days respectively; and the behaviour of the epidemic in the Essex Regiment (detailed in *Section II*) points to about five weeks as probably the longest usual interval between inspection and onset of illness. Further observations are much needed in regard to this matter.

Diagnosis.—All cases admitted to the military hospitals in Malta, that have been returned as Mediterranean Fever, have been diagnosed as such, both by their clinical features, and by the results of the agglutination test; this has been invariably applied, and no case has been returned as Mediterranean Fever unless the reaction has been definite and complete.

Section I.

The most important points in regard to the sanitary condition of the barracks in Malta may be shortly summarised under the general headings of situation, construction, water supply, and drainage.

In Valletta itself, and Floriana, there are seven separate barracks, all more or less antiquated in their plan and construction.

In *Lower St. Elmo* an infantry battalion (2nd Essex Regiment until July, 1905, then 1st Lancashire Fusiliers) is accommodated in a part of the fortress that occupies the extremity of the promontory

separating Marsamuscetto or Quarantine Harbour from the Grand Harbour.

The fort adjoins the sea on two sides, but, being excavated in the rock, the barracks are entirely deprived of any advantage from this proximity; while on the south they adjoin the most densely inhabited part of the city, and on the east are shut in by the more elevated part of the fort, called Upper St. Elmo. The barrack rooms, 52 feet in length, are casemates arranged in two tiers, and are very imperfectly ventilated; they accommodate 23 men in each, and the cubic space is barely 600 feet per head. The drinking water supply is ample; a second quality of water is provided for ablution, not always in quite sufficient quantity; sea water is laid on for flushing purposes. The latrines are water-closets of good pattern, and have recently been fitted with new automatic flushing apparatus; the urinals are of the ordinary type, having a scanty flush of water, and being also treated with a coating of kerosine oil. The drainage has been remodelled in recent years, and is satisfactory; the soil pipes are ventilated, and accessible inspection chambers provided at junctions of the underground drains, which discharge into the Civil Government sewer.

The water supply and drainage arrangements of these barracks are in the main satisfactory; their construction is very insanitary, the ventilation bad, and the cubic space insufficient. Although it is the practice in Malta generally to issue tentage during the summer months, sufficient to allow of 25 per cent. of the troops sleeping out of the barrack rooms; since June, 1903, Lower St. Elmo has been excepted from this privilege, for reasons which I have not been able to ascertain. These barracks are, in my opinion, more in need of this thinning-out process than any others in the whole island. The accessories are fairly satisfactory, except that one of the cookhouses adjoins a stable.

Upper St. Elmo adjoins the last mentioned on the east, is at a higher level, and is in every way more advantageously situated, being freely exposed either to the sea or the harbour on three sides. The barracks are occupied by two companies of Royal Garrison Artillery; but, the quarters being insufficient for their accommodation, many of the men live and sleep in tents. A lower portion, consisting of two tiers of small casemate rooms, is occupied by 96th Company R.G.A.; the rooms, being only about 25 feet long, are not difficult to ventilate, but the cubic space allowed (440 to 536 cubic feet per head) is very small. The upper portion consists of rooms of more modern construction, and not of casemate shape; but the cubic space, about 550 cubic feet per head, cannot be considered as sufficient. The water supply is satisfactory. The latrines are not satisfactory; the lower latrine, used by 96th Company, has recently been fitted with an automatic

flush, but it is in a dark and cramped situation; the upper latrine, used by 65th Company, was in a bad state at the time of my visit, the flushing arrangement being completely out of order, and the pans full of excreta. The urinals are scantily flushed; oil has not been taken into use. The drains are generally in a satisfactory condition, accessible inspection chambers being provided where required; some points of detail need attention in regard to the drainage of the new sergeants' mess.

The barracks generally are better than Lower St. Elmo; but the continual use of tents in this very confined situation must lead to fouling of the ground.

St. James Cavalier is a small barrack, accommodating a detachment of 138 men belonging to the Royal Garrison Artillery stationed in Upper St. Elmo, at present 65th Company. It is situated in the upper part of Valletta, the barrack rooms being casemates similar to those in Lower St. Elmo; two of the rooms are 51 feet in length, with most inadequate openings for ventilation; they are, however, authorised to accommodate 32 men in each, giving a cubic space of only 535 feet per head, which is quite insufficient; four other rooms are not so long, and therefore not so hard to ventilate; all the six rooms are authorised to hold more men than there is actually space to accommodate, unless the bed-cots are arranged in three rows, a practice which would be most insanitary, and is universally condemned. At least 750 cubic feet should be allowed per head; and, even with this increase, it is doubtful if No. 6 room would be reasonably fit for occupation. The drinking water supply is satisfactory, also that for ablution; but for latrine flushing it has had to be carried up by hand. Throughout the greater part of the past summer all the water supply for the latrine has had to be carried up by hand, as a regimental fatigue, the result being that a minimum quantity has been provided, and the condition of the latrine has been insanitary. It is absolutely necessary that water should be laid on to a latrine in a permanent barrack. With this exception the drainage arrangements are satisfactory. The situation is bad, and the construction of the barracks insanitary.

Floriana Barracks, including Salvatore Counter Guard and Notre Dame Ravelin, are occupied by a battalion of infantry, at present the 1st Royal West Kent Regiment. They are situated on the north side of Floriana, and within the outer line of the landward defences of Valletta, of which they form a part. The *old* portion of these barracks consists of a range of 12 casemate rooms, about 80 feet in length, each accommodating 30 men, with an allowance of from 700 to 1203 cubic feet per head. In casemates of this length, with no window openings except at the two ends, it is impossible to secure proper ventilation. At present the barracks are not crowded, as the

accommodation is sufficient for 920, and the battalion does not number more than 780. A peculiarity of these barracks lies in the circumstance that the Malta Civil General Hospital occupies the upper part of a building, on the ground floor of which are the regimental offices, stores, &c. There is no communication between the ground and upper floors, and the drainage of the hospital is quite distinct from that of the barracks, but it is most undesirable that such a building, into which infectious cases (*e.g.*, possibly cholera or plague-striken sailors) might be admitted, should form part of a structure occupied as a British barrack.

The *New* Barracks consists of three blocks of two-storey buildings, each accommodating one company, that have only recently been completed; the rooms are well arranged, according to modern principles, each holding 26 men, with an allowance of 755 cubic feet per head.

The rooms in *Salvatore Counter Guard* are small casemates with no through ventilation at all, and with a scarp wall distant only 12 yards from the front of the rooms; the movement of air must be very limited at any time, and adequate ventilation impossible; in spite of this, the allowance of cubic space is less than 600 feet per head; neither have the men been thinned out at night during the hot weather.

Notre Dame Ravelin consists of a range of 16 small rooms on the ground floor, accommodating 5 men in each, with an allowance of 900 cubic feet per head; and of seven huts, each for 18 men, with 600 cubic feet per head. These are all well ventilated, and of satisfactory construction. The huts stand on a concrete platform, and are slightly raised from the ground.

There is a good supply of No. 1 water for drinking, and No. 2 water for ablution purposes; for flushing the supply (No. 2) is sometimes defective in the Old Barracks; a larger tank and separate supply for the latrine seem to be required. The drainage of all these barracks is of modern construction, and, in the main, satisfactory. One of the latrines in the New Barracks was in bad order at the time of my visit, partly owing to a structural defect; and in several places the internal surface of the drains is uneven, leading to obstruction, or retardation of flow; gully gratings are in some places deficient. The urinals are treated with oil, and also flushed with water.

Of these barracks it may be said that the New Blocks and Notre Dame Ravelin are satisfactory, but that the Old Barracks and Salvatore Counter Guard are bad, and incapable of being made suitable for accommodating troops. Great complaints are made of the extensive fouling of the ground in the neighbourhood of these barracks, where a large number of Maltese labourers are employed in road-making, etc. The troops have no control over these people, and the civil authorities appear to be powerless in the matter.

St. Francis Barracks, Floriana, are a small range of barracks of very old type, partly on one, partly in two stories, occupied by a company of Royal Engineers. Nos. 3 and 4 rooms on the ground floor are large apartments, 66 × 29 feet, authorised to accommodate 45 men in each; the ceiling is arched, and, if the height be reckoned as 26 feet, the cubic space per head amounts to 1079 cubic feet, as shown in the Barrack Return; but if 12 feet of height only be reckoned (according to the general rules for calculating cubic space), the amount per head is only 500 feet. The means of ventilation are insufficient. Nos. 6 and 7 are large rooms on the upper floor, fairly well provided with windows and ventilating openings, but difficult to ventilate, on account of their excessive width, 40 feet. These are very unsatisfactory barracks; if they are to continue to be occupied, a cubic space of 750 feet should be allowed, and no greater height than 12 feet should be reckoned as available for ventilation purposes. The water supply is satisfactory. The latrine and urinal are of very old pattern, and require reconstruction; the drainage is modern, and in good order.

Marsamuscetto Barracks, occupied by the Army Ordnance Corps, consist of two rooms on the ground floor, each accommodating 41 men; the rooms are arched casemates, 72 feet in length, having windows only at one end; adequate ventilation is impossible, yet the effective cubic space (reckoning a height of 12 feet) is only 540 feet per head. The number of actual occupants is at present less than half the allotted number, so that there is no overcrowding; but the building is unsatisfactory. The latrine is within 20 feet of the cook-house; it is flushed only twice a day; a third flush at least is required. The urinal is intermittently and scantily flushed with water. The drainage is in good order.

The *Old Laboratory Barracks*, occupied by Army Service Corps, Army Pay Corps, Military Foot Police and Garrison Staff, consist of four rooms at an upper level, and two at a lower level; the upper ones are arched casemates, with very inadequate ventilation; the lower ones are in a very cramped and confined situation. The latrine is exceedingly cramped, dark, and ill-ventilated. The barracks are said to be condemned. They are incapable of being made really satisfactory from a sanitary point of view. The water supply and drainage are inadequate.

Manoel Fort and Hutments together accommodate an infantry battalion; up to the beginning of June they were occupied by the 1st Rifle Brigade, since then by two companies of the Lancashire Fusiliers. The situation, on a small island in Marsamuscetto Harbour, is favourable, with free air space all round. Seven of the barrack rooms in the fort are casemates, about 32 feet in length, each accommodating nine men, with 600 cubic feet per head; being small rooms their ventilation would not be unsatisfactory, but that the blank wall

of the chapel and officers' quarters is only a few feet distant from the front of the rooms, and materially interferes with the free passage of air. Three other rooms, accommodating 36 men in all, are free from this disadvantage. The hutments consist of 28 huts, each accommodating 18 men; they are well raised from the ground on pillars; the surface beneath is cemented, clean, and dry, and they are not overcrowded. The water supply is satisfactory; No. 1 water is used for drinking and washing in the hutments; in the fort, No. 2 water is collected in tanks in the rainy season, and used for ablution and flushing purposes. The latrines are all on the dry earth system; a double set of buckets is provided, but the excreta are removed only once a day, in the early morning. The water drainage system takes urine and ablution water, and discharges direct into Marsamuscetto Harbour; it is of modern construction, and satisfactory. Except for the retention of the dry earth system, these barracks are in a good sanitary condition. A connexion should be made with the Civil Government sewer as soon as possible.

Tigne Barracks, occupied by three companies of Royal Garrison Artillery, consist of the old fort, two new blocks of quarters, and 15 huts; in addition are married quarters, offices, institutes, &c., all of modern construction. The situation is excellent, having the open sea to the north and east, and Marsamuscetto Harbour to the south. The fort contains only a few small rooms; one on the upper floor is well ventilated; seven on the ground floor are at a lower level surrounded by the fort wall, and badly ventilated; only two are in present occupation, and all (it is said) will be evacuated shortly. The two new blocks, each accommodating 100 men, are two stories in height, and satisfactory in every way; except that the urine tubs have to be carried *through* the rooms on the upper floor from the verandah at back to the staircase in front, thereby leading to fouling of the floor with possibly infective material. The huts accommodate 18 men in each, are well raised off the ground, which is concreted and easily kept clean, and are not overcrowded. In the summer 25 per cent. of the men sleep in tents; in 99th Company no trestles or bed boards were supplied, and the men's mattresses were placed on the ground; this should not be allowed.

At present No. 1 water is used for all purposes, 20 gallons per head being allowed for everything. Until recently the latrines were on the dry earth system; now that a water latrine has been erected, it will probably be necessary to draw on the rain-water tank beneath the barrack square; but it would be better to lay on a supply of flushing water. In the fort the ablution water and urinals drain into a system that eventually enters the open sea; a dry earth latrine remains in use, which is regrettable. For the rest of the barracks an excellent modern drainage system has just been completed, discharging into the

Civil Government sewer. Two dry earth latrines still remain in the western part of the barracks, one being for the use of the school; the other is no longer required; this should be closed, and a water latrine provided for school use. A large new latrine has just been opened to the north-east of the barrack square, containing 34 seats; this is flushed three times daily, at present with No. 1 water. It is an important question, affecting several barracks, whether this No. 1 water, the supply of which is very limited, should be used for flushing purposes. There is great danger of the quantity being restricted, leading to an offensive and insanitary condition of the latrines; it is also very doubtful whether its use for this purpose is justifiable under the circumstances obtaining in Malta. I am very strongly of opinion that a supply of flushing water should be laid on to all latrines, and used in great abundance; and that No. 1 water should only be used (as a rule) for drinking and cooking purposes. In the present case the greatest care should be taken to prevent this new latrine, connected with a new system of drainage, from degenerating into the filthy and dangerous state that so many of the latrines in Malta have been allowed to get into, principally through deficiency of a proper supply of water, in some instances unavoidable, in other instances the result of neglect.

The urinals are treated with paraffin oil and lampblack, and water flushing is used as well. The new urinal contains 26 stalls, the authorised allowance (4 per cent.) for the number of troops occupying the barracks. It is extremely inconvenient to collect all the urinals together in one place; and when so many stalls are provided in one range most of them are not used; not more than six or eight stalls are ever required in one range; the rest are useless, and lead to a great waste of water.

Except for the minor points of detail, these barracks are satisfactory in every way as regards situation, construction, water supply, and drainage; but care must be taken in regard to the matter just mentioned in order to maintain this satisfactory condition; if water is stinted for flushing purposes, the state of things will be very different.

To the south-east of the Grand Harbour, and elevated a considerable height above the sea level, lie the Verdala Barracks, a chain of fortifications called the Cottonera Lines, and at the harbour's mouth Fort Ricasoli.

Verdala Barracks, occupied by an infantry battalion (2nd Hants), consists of 66 small casemate rooms, each about 25 feet in length, and accommodating 10 men; they are disposed on two floors and in two rows; being small rooms, and in a fairly airy situation, their ventilation presents little difficulty; the cubic space allowed is, however, only 515 feet per head, which is not sufficient; the accoutrement shelves are fixed to the walls in a continuous line, and the bed-

cots are only 12 inches apart from each other. Drinking water is laid on, and the supply is ample; for washing, No. 2 water is pumped up by regimental fatigue; until July, 1905, all the water required for flushing purposes was also similarly pumped up; now, however, salt water is laid on for this purpose, but the supply at the time of my visits was uncertain, and frequently No. 2 water had to be pumped up, regimentally, as before. The regimental latrine is situated rather near the cookhouse; it is of Jennings' continuous pipe pattern, and until recently was only flushed twice a day; it is now flushed three times daily, at 9.0, 2.0, and 5.0, and this is hardly sufficient. When a proper supply of salt water for flushing is available, it should be done four times a day. The urinal has 14 stalls, aggregated together, many of them being never used; both water flushing and oil application have been practised, the former ineffectually; the stone floor is very uneven and requires putting in order. The underground drainage is modern and, on the whole, satisfactory. Some additional ventilation to the system would be advisable, and provision for automatic flushing instead of the present inefficient method of flushing by hand with barrels of salt water, when it is available. The sanitation of these barracks has been well looked after, under circumstances of considerable difficulty.

The quarters which together make up the *Cottonera Lines* are, St. Clement's Bastion, Zeitun Gate, Polverista, St. John's and St. Paul's Bastions, Couvre Porte, Vittoriosa, Fort Salvatore, Zabbar Gate, and Notre Dame; accommodating in all about 780 men, that is, an infantry battalion. In the early part of 1905 they were occupied by the Royal Sussex, and then by the Lancashire Fusiliers; since the departure of this regiment for Lower St. Elmo they have been mostly vacant, except for detachments of the Hants Regiment in Polverista and St. Clements. All of the barracks are old and defective in many ways; proper ventilation is very difficult; if their occupation is continued, at least 750 cubic feet per head should be allowed, reckoning only a height of 12 feet as of any value for ventilation purposes. The small rooms at Zeitun Gate are fairly sanitary; but the larger ones, Nos. 5, 6, and 7, measuring about 32 × 20 feet, without any windows except in the front wall, are impossible to ventilate satisfactorily. The rooms in Polverista, which are arched casemates, 33 feet long, accommodating 14 men in each, are also very inadequately ventilated. The small rooms in St. John's and St. Paul's, although inconvenient, are not difficult to ventilate. At Couvre Porte, No. 11 room has no window at all, and is unfit for occupation. Vittoriosa has three large rooms, each accommodating 34 men, which are airy and well lighted, though a proper cross ventilation is not possible. The three large rooms at Fort Salvatore, each measuring about 80 × 20 feet, cannot be adequately ventilated by the very small openings that at present exist. At

Zabbar Gate the two large rooms, though light and airy in appearance, are very hard to ventilate, on account of their great width, 36 feet. Notre Dame, consisting of eight small rooms, is fairly satisfactory.

The water supply of these small barracks is a matter of some difficulty, and in connexion with the latrine arrangements requires more attention than has hitherto been given to it. No. 1 water for drinking is laid on, and is sufficient and always available. For washing purposes and for flushing latrines and drains No. 2 (collected rain-water) has, until last July, had to be pumped up by regimental fatigues; at Polverista the pump has broken down several times (twice during the time I was making my visits to the barracks in July and August); the labour of working this pump appears to be excessive. I was informed that a fatigue of nine men, working six hours a day, was required. On three occasions I found the latrine empty of water, but fouled with excreta; this appeared to be a not uncommon occurrence. It has been the same with the other outlying barracks. Salt-water flushing is in course of being provided, but so far the supply has been uncertain. Until an ample supply of water is available for adequately flushing the latrines—at least three times a day—and for keeping the extensive system of drains in good order, these barracks are not fit for occupation.

The drainage generally is modern and satisfactory in construction. There has been considerable complaint of bad smells in front of Polverista; the drains are properly constructed, but more water is required for flushing the verandah drain and down pipe leading into the collecting drain below.

Fort Ricasoli lies at the mouth of the Grand Harbour, on its eastern side, in an ideal situation; it is open to the Mediterranean and the harbour in three directions, and has the open country to the east, with no villages near. An ample supply of drinking water is laid on, used also for ablution purposes, and salt water is drawn from the sea for drain flushing, by a pump independent of any other supply. The drainage passes direct into the sea, by three independent systems of drains, which have been laid down within the last few years according to modern principles, and which are in good order. Some additional provision of fresh air inlets would, in my opinion, be desirable. The latrines and urinals are well kept, a mixture of tar and kerosine oil being used for the latter; one latrine was found to be without any water (but full of excreta) on one occasion, owing (so I was informed) to choking of the branch supply pipe; even under the quite exceptionally favourable conditions as regards water supply at Ricasoli, strict supervision and watchfulness are necessary.

The barrack rooms are mostly large and lofty, having plenty of window space on one side (facing the square), but no openings on the other (which is the outside of the fort); five such rooms are each over

100 feet in length by 22 feet wide, accommodating between 50 and 60 men in each; being about 23 feet in height, the cubic space per head (about 1100 feet) is large; but it is not all available for ventilation purposes, not more than 12 feet of height being really effective; on account of this height and the width of the rooms, it is difficult to get a free change of air. The bed-cots are placed very close together. No. 1 room, 80 × 22 feet, has two windows only on one side, and a doorway at one end; there are no windows on the other side or at the far end, which is quite unventilated.

The actual barrack accommodation is for 480; but three companies Royal Garrison Artillery are normally stationed here, with a strength of about 700; about 120 are quartered in outlying forts, and about 150 in tents pitched in the barrack square, occupied all the year round. In the summer 25 per cent. extra tent accommodation is drawn. Although the construction of the barracks is not sanitarily satisfactory, the general good hygienic conditions of Ricasoli, and its fine airy situation, should make it a healthy station.

Outlying Forts on the eastern side:—Small bodies of men are accommodated in several small forts in this direction. In every case the cubic space is sufficient, though, from military exigencies, ventilation is restricted; drinking water is laid on to all the forts; but for some months during the past summer this pipe supply has been cut off, and the water has been carried out to the forts in barrels. The drainage arrangements are generally satisfactory, as regards slop water and urine; dry earth latrines are in use. These require to be more carefully supervised, and the removal should be more frequent.

The barracks hitherto mentioned have been, in the main, old buildings, dating from a pre-sanitary era, though added to from time to time, and with drainage and water supply modernised more or less efficiently. On the north side of the island are two extensive ranges of barracks, one of which, St. George's, was built in 1860, and has since been added to, and the other, St. Andrew's, has only been completed in the year 1905. Each of these accommodates an infantry battalion.

St. George's Barracks, occupied by the Royal Dublin Fusiliers, consist principally of single-storey blocks of small barrack rooms, accommodating 13 men in each, with 605 cubic feet per head; these are of good construction, and very fairly well ventilated; the accoutrement shelves are fixed to the walls in a continuous line, and the bed-cots are only 12 inches apart from each other, which causes what may be called an artificial overcrowding at night. There are two new double-storey blocks of quite modern design, airy, well ventilated, and well arranged; the rooms accommodate 16 or 18 men in each, with an allowance of 750 cubic feet per head. A defect in the arrangements is that the urine tubs have to be carried through the

rooms on the upper floor, from the back to the front (as at Tigne), thereby leading to fouling of the floor with urine, which is most undesirable.

No. 1 water is laid on for drinking and also for washing, the supply being quite ample; it is also laid on to the married quarters for flushing purposes as well. In the barracks sea water is pumped up for latrine and drain flushing, but owing to defects in the pumping arrangements, the quantity of water provided has been insufficient, and the latrines have not been properly cared for. The drainage is of modern construction throughout, and is well looked after; the latrines are flushed three times a day if water is available; the urinals are in good order, a mixture of lampblack and kerosine being applied. There are several minor defects, which might be easily rectified; one frequent source of drain obstruction in Malta is the readiness with which sand and gravel are blown into and washed into and through gullies; in these barracks, which are well exposed to the wind, this occurs to a considerable extent, and causes some difficulty in keeping the drains clear; raised parapets, to keep out surface washings, and deep traps might be supplied in some places with advantage.

St. Andrew's Barracks were only completed in the early part of 1905, and were taken over by the 1st Battalion Rifle Brigade in June. They consist of nine double-storied company blocks, the rooms accommodating 14 men in each, with a cubic space of 800 feet per head. They are satisfactory in every detail, except for the necessity of carrying urine tubs through the rooms on the upper floors. The water supply is No. 1 for all purposes. The drainage is satisfactory in its main features, but there are several points of detail that require attention, such as the provision of accessible manhole covers (instead of cemented slabs), easing off of right-angled junctions, etc.

Pembroke Camp is a musketry camp near St. Andrew's Barracks, occupied by parties of men from various regiments in succession throughout the whole year, as many as 800 or 900 being sometimes under canvas at once. Its sanitary condition is very unsatisfactory. The ground is rocky and uneven, and difficult to keep clean; the sites of the tents are never, or hardly ever, changed. There is one dry earth latrine of 26 seats for the whole camp; this is not sufficient accommodation for the numbers that are frequently present; the latrine seats are badly constructed, being too high (or the pails placed too low); fouling of the ground with urine results. The pails are removed only once a day, between 4 and 5 a.m., the result being that for the greater part of the 24 hours the air of the camp is fouled by excretal emanations; flies are also attracted in great numbers. The woodwork of the latrine is in bad repair. The urinal consists of a

plain marble slab like a native convenience; it is flushed with water and no oil has been applied. At the north-west end of the camp is a cesspit, connected with the officers' W.C., apparently unventilated, and in close proximity to the water tank and officers' cookhouse. A water drainage system is now being carried out, and this cesspit should be removed.

Pembroke Camp is in a very bad sanitary state, not due to any want of care on the part of the camp authorities, but on account of obvious defects of design and construction in what may be called minor details. A small *permanent* sanitary staff should be provided to keep the camp in as sanitary a condition as may be possible, and lessen the difficulties resulting from the constantly shifting character of the population.

In regard to the *Outlying Forts* in the Western District the same remarks apply as to those in the Eastern, except that No. 1 water is laid on in each case, and is ample in quantity. The dry earth system is in use, and is fairly satisfactory, except at Maddalena, where the accommodation is insufficient, there being only two latrine seats. Everywhere removal only takes place once a day, which is not enough. A modern drainage system for slop water, &c., has been laid down in each case.

Imtarfa Barracks consist of four large blocks, accommodating 233 in each, and four smaller blocks, accommodating 110 in each, all of two stories; the rooms are constructed for either 16, 18, or 20 men, with a space of 750 cubic feet per head. They are excellent barrack rooms in every way, well built, and with every convenience. No. 1 water is laid on for drinking and washing; rainwater is collected in underground tanks, and pumped up regimentally for cleaning and flushing purposes. The latrines have hitherto been on the dry earth system, but a water carriage system will be introduced very shortly. A complete system of drainage has been constructed, to which the latrines can be readily connected up. The dry earth latrines were in a satisfactory condition at the times of my visits, but I was informed that this had not been the case earlier in the summer, and that it had been found necessary to employ regimental fatigues to apply the dry earth thoroughly. It is difficult to get the dry earth system properly carried out anywhere (though principally a matter of regimental discipline), but the difficulty is much increased in the case of a body of men who have been accustomed to the use of water latrines, that require no attention on the part of the individual. In the present case a rather considerable prevalence of enteric fever has been due, in all probability, to faulty carrying out of the dry earth method at Imtarfa. The latrines are emptied by contract once only in the 24 hours, about 2 A.M.; during the greater part of the day, therefore, they are full of excreta, and the air of the barracks proportionately fouled; flies are

quite a plague in some parts of the lines, a fact which is always significant and generally of ill omen. The urinals are treated with a mixture of colza oil and tar; this has acted most satisfactorily, applied once a week; the urinals here were in a better state than any others in Malta at the times of my visits. The underground drainage system is satisfactory on the whole; at one or two places the fall appeared to be hardly sufficient, *e.g.*, at the north-west corner of the canteen a considerable amount of deposit was found; there was also a good deal of deposit in the main collecting drain at the east end of the barracks, north of the junction with No. 1 cookhouse drain; in both places this has, I understand, occurred before, more than once. Additional flushing is required, and careful supervision to see that no stoppage takes place.

Some surface drains which take the washings of the verandahs of married quarters lead into the foul drainage system, passing through a gully trap to cut off the foul air. Such is the case in M, N, O, and P Blocks, Married Quarters. But the verandahs of these blocks are not habitually, and probably very seldom, if ever, washed down with water; consequently in dry weather no water gets into this gully, or at least not enough to provide an efficient seal. The trap was unsealed at the time of my visit, in the case of each of the above-mentioned blocks, the trap being almost dry, and choked with sand, which at the bottom was moist and foul-smelling. These traps require to be seen to, and filled with water periodically. The sewage is at present conveyed to a kind of septic tank, the effluent from which is applied to land in the Kleir Wied, to the north of the barracks. This method of disposal is quite inoffensive.

The situation of these barracks is all that could be desired. They stand on an isolated hill, some 600 feet above the sea, exposed to the fresh air on all sides, and with no insanitary dwellings near at hand. The barracks are well constructed and sanitary; with a good water supply, and a proper system of sewerage and refuse removal, the troops should be free from all epidemic disease. It has, however, unhappily been the case that there has been a good deal of sickness this past year, due to preventable causes.

At Ghain Tuffieha and Mellieha, in the extreme west of the island, are camps used by the troops, chiefly during the winter season; also at Ghain Tuffieha is the standing camp of the Mounted Infantry, the permanent strength of which averages 250 to 300 men throughout the year. The situation of each of these camps is quite satisfactory. In each case there is a good and ample supply of drinking water laid on; also a drainage system on modern principles. At Mellieha the latrines are water latrines, and the whole of the drainage is conducted to a small septic tank, the effluent from which passes into the open sea. At Ghain Tuffieha, up to the present, the dry earth system has been in

use. The drains carry off drainage from cookhouse, stables, urinals, etc., to a septic tank, hermetically sealed up with great care, the effluent from which passes into the sea. When water latrines have been provided, in place of the dry earth buckets, and connected with the existing drains, this camp ought to be extremely healthy, provided the ordinary rules of camp sanitation are strictly carried out, and the drains carefully looked after.

Fort Chambray, Gozo, is an old fortress of the Knights, in which there is accommodation for (nominally) 400 troops. The barrack rooms, four on the ground floor and four on the upper floor, are 100 × 20 feet, with good windows at each end, but no openings, except a doorway, at the sides. They are therefore very difficult to ventilate. The accoutrement shelves are fixed to the walls, touching each other, and the bed-cots are very close together; but as only one company is at present in occupation there is no overcrowding. Drinking water of good quality is laid on from the public supply. Collected rainwater is pumped up regimentally for washing and flushing purposes. The drainage system is partly modern and partly old, but is now nearly all remodelled. On the whole it is satisfactory. A foul catchpit outside the married men's latrine, and a series of deeply-sunk silt traps in rear of the married quarters require certain obvious and easily practicable alterations. The latrines are on the dry earth system, with removal once a day only. Urinals are treated with lampblack and oil. These barracks are admirably situated for health, and are satisfactory in all important particulars.

Hospitals.

Valletta Military Hospital contains 232 beds, and also has quarters for 65 non-commissioned officers and men of the Royal Army Medical Corps. The buildings are ancient, and not well adapted for hospital purposes according to modern requirements. The situation is unfavourable, as, although it borders on the Grand Harbour to the east, on the west and south it is closely surrounded by crowded dwellings of the poorer class; moreover, the principal wards are deprived of the beneficial effects of the cool north-west wind by reason of the lofty houses built on higher ground in that direction. The wards are lofty, and, on account of the thickness of the walls, cool in summer and warm in winter.

The principal feature in the hospital is the famous "Long Ward," probably the longest room in the world, being 503 feet in internal length, without any break in the continuity of the ceiling or east wall. Its width is 35 feet, and its height 32½ feet. Near the middle a transept is given off to the west, of nearly equal width and height, and about 100 feet in length, forming part of the same chamber. To facilitate administration the whole apartment is divided by partitions,

10 feet high, into northern, southern, central, and western portions (20A, 20B, 20, and 20C); but from a sanitary point of view it is all one chamber. In 20A are accommodated 50 patients, chiefly Mediterranean and enteric fevers; in 20B are 60, venereal and slight cases; in 20 and 20C are slight fever cases. The cubic space is very large, 4000 cubic feet per head, reckoning the whole height of 32½ feet; if the height be taken as 12 feet, it is over 1500 cubic feet per head. These amounts appear to be ample. There are difficulties in ventilation, however, in spite of this ample cubic space, which, indeed, is of no advantage if it interferes with the free access of external, and exit of internal air. It is obviously more difficult to change the air of a room 30 feet wide than that of a room 10 feet wide, the amount of window space being the same in each case. In this instance the width is 35 feet, and the window space is not large. There are very few windows in the lower part of the walls. In the upper part there are plenty; but there is reason to believe that they have not been opened, and kept open, so freely as would have been desirable, and that consequently the ventilation of this large apartment has not been satisfactory. Notwithstanding its coolness and spaciousness, the difficulties in maintaining purity of the air, and the impossibility of isolating the patients, render this "Long Ward" an undesirable place in which to treat the sick, although at first sight to be very well adapted to the purpose. The wards on the upper floor are of moderate size and well ventilated. The flooring of the wards is of cement concrete, having a smooth impermeable surface that is easy to keep clean.

The water supply is good and ample for all purposes. The drainage system has been entirely reconstructed within the last few years, and is in accordance with modern requirements; the drains discharge into the civil sewers at three different points, being cut off by proper disconnecting arrangements. Accessible inspection chambers are provided freely. A few points of detail in construction require attention; as, *e.g.*, a proper grease trap for the cookhouse; abolition of the large foul catchpit near south-east corner of Lower Square. Other important requirements are (1) a new latrine for 20B Ward, the present one being in bad repair; (2) concreting the rough floor of latrine and urinal for No. 37 Ward.

The Families Hospital, though in rather a cramped situation, is fairly satisfactory.

The R.A.M.C. barrack room is a large apartment, 96 × 31 feet, with an annexe on one side 28 × 17½ feet; it is well lighted and airy in appearance, but on account of the great width and absence of cross ventilation it is difficult to secure a proper purity of the air.

Cottonera Hospital is a modern building of good general design, and is in an excellent, airy, and healthy situation, standing in its own grounds, at a considerable elevation. It has four large wards,

128×26 feet, of 32 beds each, and several smaller ones, 156 patients being accommodated in all. The wards are well designed, well lighted, and well ventilated. The ward annexes are capable of improvement. The principal sanitary defect in this hospital lies in the material of the ward floors, which are made of a soft and easily friable porous white stone; it wears away unevenly into holes, which are difficult to keep clean; the operation of ward-sweeping twice a day fills the air of the ward with fine dust, which is afterwards deposited on the patients, on their beds, and on any articles of food that may be exposed; a good deal of it must be inhaled. The floor spaces between the beds have been treated with some hardening preparation that makes the stone impermeable, but the main part of the floor in the centre has not been so treated. The provision of a smooth impermeable floor, as at Valletta, is an urgent necessity. Water supply and drainage are quite satisfactory.

Forrest Hospital (31 beds) is a hired house, not designed for a hospital, but in as satisfactory a condition as can be expected. The water supply and drainage arrangements are in good order. A considerable number of the patients (20 to 30) are treated in tents all the year round (owing to want of sufficient accommodation), which greatly adds to the difficulties of maintaining a good sanitary condition of the hospital and its accessories.

Imtarfa Hospital (42 beds) is a new building constructed in accordance with modern principles, and is in every respect satisfactory.

Citta Vecchia Sanitarium (80 beds), is an old palace of the Knights, with large airy rooms, and well fitted for treating convalescent cases; the water supply and drainage are satisfactory.

Gozo Hospital contains 15 beds, and is satisfactory in its situation and construction, water supply and drainage arrangements.

Married Quarters.

There is accommodation for about 650 married families in the Maltese garrison, and in the great majority of instances this accommodation is remarkably good. In this category are to be placed the two new blocks at Floriana, known as Misida Bastion (44 quarters), the new block in St. Francis Ravelin (6), the four new blocks at Tigne (65), D Block, St. George's (10), all St. Andrew's (36), Verdala New Block (24), Ricasoli new blocks (18), and all Imtarfa (55). These quarters are all excellent in every way, airy, and well ventilated, the water supply laid on, and good water-closets of modern wash-down pattern provided; in nearly every case also the situation is good; they are some of the most agreeable residences in the island. There are certain minor defects in sanitary detail that require attention, but nothing to interfere with their permanent usefulness, healthiness, or convenience.

The largest block of married quarters in Valletta is the building known as the Camerata, facing the Valletta Military Hospital; this accommodates 92 families, and is generally nearly full. It is an old building of six stories, and is comparable to a block of artisans' dwellings in London; being situated in the middle of the town, it is not so fresh and airy as other quarters, and some of the rooms are without direct communication with the external air; new closets of first rate pattern have been recently supplied on each floor, and the building is kept in admirably clean and good order; so that, in spite of its being somewhat crowded it is really quite a sanitary and satisfactory block of dwellings.

The other older quarters, such as those in Upper and Lower St. Elmo, Floriana Pavilion (14), St. Francis Ravelin (16), Fort Manoel, the old blocks at St George's (55), the old quarters at Ricasoli (20); St. Nicholas and Gozo (21), though not so convenient, or so well off in the way of closet accommodation and water supply, are nevertheless in a fairly good sanitary condition.

The large block of hired quarters in Strada Magazzini, Floriana, has been put into as good a condition as is practicable in regard to water supply and sanitary arrangements; but there are certain grave defects of construction in regard to the drainage (faulty pattern of W.C. liable to become untrapped, ill-ventilated closet chambers, inferior work in the underground drains) that prevent their being considered satisfactory quarters; they resemble the ordinary private houses in Valletta, etc., and are not to be compared to any of the newly erected married quarters that have been just mentioned. The hired quarters at Tigne are to be placed in the same category; those in Strada Capuccini, Floriana, are satisfactory.

There are some married quarters on the Cottonera side (Fort Salvatore (14), Vittoriosa (3), and St. Nicholas Back) that are very undesirable residences, and, indeed, hardly fit for occupation.

On the whole, the accommodation for married families is extremely good, and, from a sanitary standpoint, very satisfactory.

Section II.

§ 1.

The following table shows the incidence of Mediterranean Fever in the different barracks and hospitals in Malta during the nine months January to September, 1905:—

Table I.

—	Average population.	Number of cases.	Ratio per 1000.
Upper St. Elmo	392	26	66·33
Lower St. Elmo	613	84	137·03
Floriana	717	37	51·60
St. Francis	201	9	44·77
Manoel	474	29	61·18
Tigne	492	31	63·01
St. George's	1051	42	39·96
St. Andrew's (4 months)	624	15	54·00*
Verdala	618	18	29·13
Cottonera Lines	779	44	56·48
Ricasoli	639	15	23·47
Imtarfa	856	35	40·88
Various Barracks	650	28	43·08
Ghain Tuffieha Camp	473	4	8·45
Various Camps	—	14	—
Valletta Hospital	231	33	142·86
Cottonera Hospital	147	17	115·65
Various Hospitals	157	6	38·22
	9114	487	—

* Ratio calculated for nine months; the actual ratio for four months was 24·04.

The occupation of these barracks is as follows: Upper St. Elmo (old buildings), Tigne (principally huts and new buildings), and Ricasoli (old buildings), are occupied by Royal Garrison Artillery, of which there are eight companies (having an average strength of about 200 each), and a district establishment amounting to about another 200. Three companies are stationed at Tigne and outlying forts to the west; three companies at Ricasoli and outlying forts to the east; and two companies at Upper St. Elmo and St. James Cavalier. There has been little variation in the strength of the Royal Artillery during the year, which in January was about 2000, except a reduction during April to about 1800.

St. Francis is occupied by Royal Engineers, who have a total strength of about 380, many living in detached quarters; the numbers have not changed during the year.

Infantry battalions are accommodated in the old barracks of Lower St. Elmo, Floriana, and Verdala; in the new barracks of St. George's, St. Andrew's, and Imtarfa; in Manoel, which is partly an old fort and partly a hutment. Another battalion occupied until lately various old fortress barracks known collectively as the Cottonera Lines; and a detachment occupies Fort Chambray in Gozo. Several changes have occurred in the *personnel* of the infantry during the year. In January

the battalions present were the Sussex, Hants, Essex, West Kent, Rifles, Dublin Fusiliers, and Rifle Brigade, each from 900 to 1000 strong; and a wing of the Yorkshire Light Infantry, 500 strong. These last and the Rifles left the island in March, and the head-quarters and five companies of the Sussex left in May. In February the Lancashire Fusiliers arrived, about 700 strong, being increased by about 100 in March. During April all the battalions were reduced in strength, the Essex and Rifle Brigade losing about 150 each, the West Kent and Dublins about 100 each, the Sussex and Hants about 50 each; so that during the five months, May to September, their strength was between 800 and 900, except the Hampshires, which remained at 1000.

The Departmental Corps occupy Marsamuscetto and Old Laboratory Barracks, the various hospital quarters, and hired quarters in different parts. The total combined strength has not varied, being about 350.

Valletta and Citta Vecchia Hospitals are old buildings, Cottonera and Gozo are modern, Imtarfa is a quite new building, and Forrest is an old hired house, not built for a hospital, but now many years in occupation as such.

Ghain Tuffieha is a permanent camp for Mounted Infantry, with an average strength of 180; and also accommodates battalions under training at different times during the cold season. Pembroke is a standing musketry camp, with a floating population, and Mellieha and other camps are occupied from time to time for field training.

An examination of Table I shows that the incidence of Mediterranean Fever during the first nine months of 1905 has varied considerably in different localities. A total of 487 cases in a population of 9100 gives a general ratio, for the period, of 53·52 per 1000; this varies in different places between 8·45 at Ghain Tuffieha Camp and 142·86 at Valletta Hospital. Arranged according to the severity of prevalence, the different barracks, etc., stand as follows:—

	Attack ratio per 1000.
Valletta Hospital	143
Lower St. Elmo	137
Cottonera Hospital	116
Upper St. Elmo	66
Tigne	63
Manoel	61
Cottonera Lines	56
St. Andrew's	54
Floriana	52
St. Francis	45
Various barracks and camps	43

	Attack ratio per 1000.
Imtarfa	41
St. George's	40
Various hospitals	38
Verdala	29
Ricasoli	23
Ghain Tuffieha Camp	8

The items "Various Barracks and Hospitals," and "Cottonera Lines," including many detached forts and buildings, should be disregarded in this list, the numbers occupying any individual locality being too small to enable any safe conclusion to be drawn as to factors in causation. The following points call for explanation:—(1) the excessive prevalence of the disease in the two hospitals at Valletta and Cottonera, and in the barracks at Lower St. Elmo; (2) the relative immunity of Verdala, Ricasoli, and Ghain Tuffieha; (3) the difference in prevalence between the adjoining barracks of Lower St. Elmo (137 per 1000) and Upper St. Elmo (66 per 1000), the buildings of which are within a few yards of each other.

The next table (II) shows the relative incidence in the different barracks and hospitals month by month. It is seen (1) that Mediterranean Fever, present to a slight extent in January and February, increased in March, and again very considerably in May, the increased number of cases continuing with no diminution during the rest of the hot weather; and this in spite of the fact that the strength of the troops was decreased by about 800 in April, and again by about 600 in May. (2) It is also seen that the disease did not prevail throughout the island generally with the same degree of intensity at any one time; thus at Floriana there were nine cases in March, no other barracks showing more than three or four cases in this month; after April very few cases occurred at Floriana. In May there were 11 cases in Manoel and 17 in Lower St. Elmo; but though Lower St. Elmo continued to be severely affected throughout the summer, Manoel was practically free after June. St. George's had few cases until June, and Imtarfa few until August. There was therefore a very uneven distribution of cases, month by month, which appears to contra-indicate any one general condition, climatic or other, affecting the whole barrack population.

Table II.—Distribution of Mediterranean Fever Cases, 1905.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Total.
Upper St. Elmo	—	2	4	4	4	5	4	—	3	26
Lower St. Elmo	2	—	3	6	17	19	15	10	12	84
Floriana	2	4	9	7	2	3	4	3	3	37
St. Francis	1	3	2	—	—	1	1	—	1	9
Manoel	1	—	3	4	11	7	—	1	2	29
Tigne	—	2	4	1	7	1	6	3	7	31
St. George's	1	—	1	—	5	10	5	15	5	42
St. Andrew's	—	—	—	—	—	—	3	5	7	15
Verdala	—	2	1	1	—	5	1	4	4	18
Cottonera Lines	2	4	7	3	4	5	13	4	2	44
Ricasoli	—	1	—	—	2	3	2	7	—	15
Imtarfa	1	1	1	2	2	3	1	14	10	35
Various barracks	—	—	1	2	4	2	2	6	11	28
Ghain Tuffieha Camp	—	—	—	2	—	—	—	1	1	4
Various camps	—	—	4	4	2	—	—	2	2	14
Valletta Hospital	2	—	1	2	5	6	7	6	4	33
Cottonera Hospital	—	—	—	—	6	5	1	3	2	17
Various hospitals	—	1	—	—	—	—	2	2	1	6
	12	20	41	38	71	75	67	86	77	487
Strength	10,225	10,329	9853	9471	8661	8025	7984	7881	7855	—

Table III shows the incidence of the disease amongst the different corps stationed in Malta during the first nine months of 1905.

Table III.

——	Average strength.	Number of cases.	Ratio per 1000.
Royal Garrison Artillery	1941	88	45·34
Royal Engineers	363	12	33·06
1st Lancashire Fusiliers (7 months)	815	51	62·58*
2nd Royal Sussex	642	31	48·29
2nd Hampshire	997	27	27·08
2nd Essex	951	84	88·33
1st Royal West Kent	827	37	44·78
2nd Yorkshire Light Infantry (3 months)	539	—	—†
1st King's Royal Rifles (2 months)	1043	2	1·92‡
1st Royal Dublin Fusiliers	900	41	45·56
1st Rifle Brigade	849	46	54·18
Army Service Corps	76	2	26·32
Royal Army Medical Corps	155	30	193·55
Army Ordnance Corps	80	5	62·50
Army Pay Corps	21	3	142·86
Miscellaneous	—	2	—
Cases occurring in hospital (not R.A.M.C.)	—	26§	—
	—	487	—

* The Lancashire Fusiliers arrived on February 27; the ratio is for the actual period of seven months; assuming the same rate of prevalence, the ratio would be 80·46 for nine months.

† The Yorkshire Light Infantry left in March.

‡ The King's Royal Rifles left in February; the ratio is for two months.

§ These are not included in the regimental figures, because removed from regimental conditions.

An examination of this table shows that the incidence varied considerably in the different corps. The general ratio throughout the troops has already been stated as 53·52 per 1000 for the period: arranged according to severity of prevalence, the corps stand as follows, only those present throughout the whole period being considered:—

	Attack ratio per 1000.
Royal Army Medical Corps	194
Army Pay Corps	143
Essex	88
Army Ordnance Corps	62
Rifle Brigade	54
Royal Sussex	48

k

	Attack ratio per 1000.
Royal Dublin Fusiliers	46
Royal Garrison Artillery	45
Royal West Kent	45
Royal Engineers	33
Hampshire	27
Army Service Corps	26

The respective numbers of the Army Service, Ordnance, and Pay Corps are so small that it would not be safe to draw any conclusions from them. The points that call for explanation are (1) the excessive prevalence of the disease amongst the R.A.M.C. and the Essex Regiment, and (2) the relative immunity of the Hampshire Regiment and the Royal Engineers.

Table IV gives the prevalence, month by month, amongst the several corps, and shows generally the same aspect of the epidemic as Table III, with which it may be compared.

§ 2.

More particular attention may now be directed to certain places where Mediterranean Fever has been especially prevalent, with a view to eliciting any circumstances that may throw light on this excessive prevalence.

Lower St. Elmo Barracks show the greatest incidence of any place, excepting the two hospitals of Valletta and Cottonera. The sanitary conditions of these barracks are shortly stated in Section I, p. 108; the water supply and drainage are in the main satisfactory, but the construction is very insanitary; the men are accommodated in casemates, 52 feet in length, with very inadequate ventilation; the situation of the barracks, which are sunk in a hollow, is also such as to render the supply of fresh air a difficulty at all times, and practically an impossibility in calm and still weather.

From the beginning of 1905 until July 8 these barracks were occupied by the 2nd Essex Regiment; on the latter date they moved to Imtarfa, and on July 11 their place was taken by the 1st Lancashire Fusiliers. This change of occupation complicates the matter, but also to some extent helps in the investigation.

The cases of Mediterranean Fever in the Essex Regiment were distributed, month by month, as follows:—

January	2	June	19
February	0	July 1 to 8	7
March	3	July 9 to 31	9
April	6	August	14
May	18	September	6

Table IV.—Regimental Incidence of Mediterranean Fever Cases, 1905.

—	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Total.
Royal Garrison Artillery	—	4	8	6	14	11	13	16	16	88
Royal Engineers	2	3	2	—	1	1	1	1	1	12
1st Lancashire Fusiliers	—	—	—	6	5	4	10	12	14	51
2nd Royal Sussex	2	4	7	2	2	4	1	4	5	31
2nd Hampshire	—	2	3	2	1	5	4	4	6	27
2nd Essex	2	—	3	6	18	19	16	14	6	84
1st Royal West Kent	1	4	8	8	2	3	4	3	4	37
2nd Yorkshire Light Infantry	—	—	—	—	—	—	—	—	—	—
1st King's Royal Rifles	1	1	—	—	—	—	—	—	—	2
1st Royal Dublin Fusiliers	1	—	1	—	4	10	5	15	5	41
1st Rifle Brigade	1	1	6	5	11	7	3	5	7	46
Army Service Corps	—	—	—	—	1	—	—	—	1	2
Royal Army Medical Corps	1	—	1	1	3	4	7	10	3	30
Army Ordnance Corps	—	—	1	1	1	—	—	—	2	5
Army Pay Corps	—	—	1	—	—	—	—	—	2	3
Miscellaneous	—	—	—	—	—	—	—	1	1	2
Hospital cases (not R.A.M.C.)	1	1	—	1	8	7	3	1	4	26
	12	20	41	38	71	75	67	86	77	487

Of these cases all, up to July 8, were admitted from Lower St. Elmo; with the exception of two in March, admitted from Pembroke Camp; and three in May, one in June, and one in July, which were admitted from Gozo. From July 9 onwards all the cases were admitted from Imtarfa Barracks, except one from Gozo and one from Ghain Tuffieha. It has been already stated that it is necessary to allow a period of 14 days for incubation in most instances, and that probably a *further period* of 14 days should be allowed in many instances, between date of contracting infection and date of admission to hospital; cases admitted more than 28 days after departure from any particular place can hardly be considered to be due to infection originating in that place. If this limit be provisionally adopted, the two cases admitted from Pembroke Camp should be referred to Lower St. Elmo, as also should three of the cases admitted from Gozo. *Per contra*, one case admitted from St. Elmo in May, 13 days after arrival from Gozo, may be debited to the latter place, though, in this instance, some doubt must be felt as to the length of the incubation period.

The 2nd Essex Regiment arrived in Malta from England, and took up quarters in Lower St. Elmo, on April 29, 1904; here six companies remained throughout the year, except for short periods at Pembroke, Mellieha, and Ghain Tuffieha Camps, returning from the last-named on December 19, 1904. Two companies were stationed at Gozo (A and B) from April 29, to September 1, 1904, on which date they were relieved by D and F Companies, who remained there until May 8, 1905; being relieved in turn, on that date, by C and E Companies.

Of the total number of cases (55) occurring in the regiment between January 1 and July 8, 1905, all, except one, belonged to the six companies stationed at Lower St. Elmo; only this one came from the two companies stationed at Gozo.

The incidence of Mediterranean Fever in the different companies during the whole period of nine months, January to September, was as follows:—

A.	B.	C.	D.	E.	F.	G.	H.	Uncertain.	Total.
11	15	4	2	3	8	19	19	3	84

The companies that have been stationed throughout the whole time at Lower St. Elmo, and subsequently at Imtarfa, have been A, B, G, H; these four companies have had 64 cases; the four companies, of approximately the same strength, that have been part of the time at Gozo (C, D, E, F), have had 17 cases; of these 17, four were admitted from, and without doubt contracted the fever in, Lower St. Elmo; seven probably contracted the disease there, and four probably at Imtarfa; in two instances only, or perhaps three, was it contracted at Gozo.

It is necessary to distinguish between what is practically certain, and what is uncertain. Assuming the correctness of the diagnosis, as to which every care has been taken (as mentioned in p. 108), there is little doubt that 84 cases of Mediterranean Fever have occurred in this battalion. As to the place where infection was contracted, there is no such certainty, because the incubation period has not yet been definitely ascertained. It is a fact to be noted that 64 of these 84 cases occurred in the four companies A, B, G, H, which remained the whole time in Lower St. Elmo and Imtarfa; in three instances, two of which were from the mounted infantry at Ghain Tufficha, the company to which the man belonged is not ascertained: of the 17 cases occurring amongst the other four companies, 11 probably originated in Lower St. Elmo. There is therefore a presumption that the excessive prevalence of the fever in this battalion was due to something belonging to, or connected with, Lower St. Elmo Barracks.

These barracks consist of a range of building in three stories, the rooms in the lowest being used as stores, cookhouse, canteen, etc., and the middle and upper stories being used as barrack rooms. They were allocated thus:—

Upper Storey—

Nos. 1 to 3.—C Company, January 1 to May 6.
D Company, May 8 to July 8.
4.—Signallers.
5 to 8.—A Company all the time.
9 to 12.—E Company, January 1 to May 6.
F Company, May 8 to July 8.
13, 14.—Drums.

Middle Storey—

Nos. 1 to 4.—B Company
5 to 8.—G Company
9 to 12.—H Company
13, 14.—Band
all the time.

The actual barrack rooms from which cases were admitted are not always ascertainable with accuracy; the following particulars as to the rooms occupied are as much as I have been able to find out:—

Upper Storey.

Nos. 1 to 4.—Cases were admitted May 9, 31; June 2 (C Co.); July 31 (D Co.); total, 4 cases.

Nos. 5 to 8.—Cases admitted March 18; May 20, 21, 31; June 6, 7; July 1, 5, 11; August 4; total 10 cases (A Co.); one other case in this company lived at the sergeants' mess.

Nos. 9 to 12.—Cases admitted April 12, 22; May 1 (E Co.); July 13, 24, 28 (F Co.); total, six cases.

Nos. 13, 14.—Cases admitted May 23 (H Co.); June 10; July 2 (G Co.); total, three cases.

Middle Storey.

Nos. 1 to 4.—Cases admitted January 22; March 16; April 6; May 2, 8, 19, 31; June 2, 10, 21; July 20; total, 11 cases in B Co., of which four at least were in No. 2, and three at least in No. 3 room.

Nos. 5 to 8.—Cases admitted January 22; April 1; May 3, 26; June 8, 10, 11, 16, 21, 26, 30; July 24, 31; total, 13 cases, all in G Co., of which four at least lived in No. 8 room; two other cases in this company were drummers, living in Nos. 12 or 13, Upper Storey.

Nos. 9 to 12.—Cases admitted March 25; April 5, 18; May 3, 20, 27; June 5, 11, 17, 28; July 2, 4, 20; August 4 (two cases); total, 15 cases, all in H Co.; of these at least three were in No. 10, and three in No. 12. One other case in this company occurred in the sergeants' rooms on the Upper Storey.

Nos. 13, 14.—One case occurred, May 6; Band, F Co.

The above list accounts for 65 out of the 84 cases that occurred in the battalion. After they moved to Imtarfa on July 8, cases continued to occur, and of these 12 have been regarded as probably due to St. Elmo infection, up to August 5. After this date infection has been considered to have been contracted at Imtarfa, though very possibly introduced from St. Elmo. Three cases were admitted from G Company on August 6 and 7, which might be thought to be more likely due to a continuance of the same influence, whatever it was, that caused the special incidence on this company, with an extra long period of incubation. Eight other cases occurred up to the end of the month, and six in September, there being a very notable diminution in this month.

Before the arrival of the Essex Regiment at Imtarfa, a few cases had been admitted from the Sussex Regiment, which had been quartered in these barracks since February 22. Besides five cases in the middle of March, probably dating from Polverista, there had been at Imtarfa one case in March, two in April, two in May, two in June, and one on July 5; the disease was present, but did not prevail at the station; the average strength of the troops during January to June was 880. No cases occurred in the Sussex Regiment after July 5 until August, in which month there were four admissions from this battalion. Granting that the length of the incubation period

is uncertain, if one compares the considerable prevalence of the fever at Lower St. Elmo with its trivial manifestations at Imtarfa during the early part of the summer, it appears more probable that the Essex cases occurring at Imtarfa were due to a "something" brought up with the regiment from St. Elmo than to any infection of local origin at Imtarfa. Whether this supposed infective "something" was brought up as an already ingested but latent *contagium*, within the bodies of the men who afterwards developed the disease, or whether it was introduced in fomites, or infective matters external to the body, is a question to be considered further. At this stage we are, I think, to some extent justified in the presumption that the Imtarfa cases, for at any rate four weeks and possibly longer after arrival at the new quarters, were due not to anything belonging to Imtarfa, but to some factor that had been in operation at St. Elmo, and which continued in operation for some time afterwards. The drop from 14 admissions in August to six in September is noteworthy.

It is worth while considering a converse instance; D and F Companies went from St. Elmo to Gozo on September 1, 1904, and returned to St. Elmo on May 8, 1905. From these two companies two cases of Mediterranean Fever were admitted on September 8, 1904, one on September 18 and one on October 3; the first three and perhaps the fourth case may be presumed to have become infected before leaving St. Elmo; a fifth case was admitted on October 8 (38 days after leaving St. Elmo), and not a single other case occurred during their eight months' stay at Gozo, nor (with one exception) during their stay at St. Elmo between May 8 and July 8; four cases were admitted at Imtarfa during the latter half of July. The one case admitted after return to St. Elmo that appears to have contracted the infection in Gozo (Private Lawrence, F Company) was admitted on May 21, 13 days after arrival. Whatever the conditions were that led to the prevalence amongst the occupants of Lower St. Elmo, they appear to have been absent from Gozo even more completely than from Imtarfa. The immunity enjoyed by these two companies while at Gozo continued for two months after their return to St. Elmo, yet in G and H Companies 21 cases occurred in the same two months, May 8 to July 8, 1905.

The 2nd Essex having marched up to Imtarfa on July 8, their quarters in Lower St. Elmo were taken over by the 1st Lancashire Fusiliers, who marched in on July 11. This regiment had landed in Malta from England on February 27, 1905, and on arrival were quartered in Polverista Barracks; they marched to Pembroke Camp on March 20, thence to Mellicha Camp on April 30, and returned to Polverista on May 8, remaining there until their move to Lower St. Elmo. Six companies then occupied these barracks, and two (B and D) went into Manoel Hutments.

The first admission to hospital for Mediterranean Fever occurred on April 5, that is 37 days after landing in Malta; the second admission was on April 17; until their move to St. Elmo there were 18 other admissions, that is 20 in 15 weeks; during the same period the Essex Regiment had 50 admissions; the prevalence in the Lancashires was, therefore, much less than in the Essex. During the next four weeks eight cases were admitted from Lower St. Elmo, having presumably contracted infection in Polverista. From August 9 to the end of September, 19 cases occurred in the six companies in St. Elmo, and three cases in the two companies occupying Manoel, presumably due to infection contracted in those places.

In this regiment, unlike the Essex, the incidence on different companies has varied but slightly. During the whole period from their landing until the end of September (seven months) the distribution of cases has been as follows:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
5	4	9	8	8	5	4	8	51

There is here no marked preponderance, as is the case of B, G, and H Companies of the Essex. Before the move to St. Elmo the distribution had been thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
2	1	2	7	2	4	1	1	20

Within the next four weeks the cases occurred thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
1	1	2	0	2	0	1	1	8

From August 8 until September 30 the cases occurred thus:—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
2	2	5	1	4	1	2	6	23

In the first set of 20 cases D Company certainly furnishes a disproportionate number, but no common origin is apparent, and the cases were spread over three months. It may be noted that two cases in A company were admitted from the same room (No. 3 Polverista) and two cases in F Company also from one room (No. 14 Polverista). These rooms accommodate 14 men in each. The battalion was quartered in a number of small barracks, including not only Polverista itself, but also all the others making up Cottonera Lines, and was therefore widely scattered. On coming to Lower St. Elmo six companies were concentrated in one building under like conditions. It is to be noted that seven cases occurred in C Company, which occupied Nos. 5 to 8 rooms in the middle storey, the same that had just been vacated by G Company of the Essex Regiment; this company had furnished 19 cases of Mediterranean Fever, 13 of which

appear to have contracted infection while occupying these four rooms, seven of these having been admitted within the preceding three weeks. Of the seven cases in the Lancashires one was a colour-sergeant who occupied the same room as a colour-sergeant of the Essex, admitted with Mediterranean Fever eight weeks before; of the other six, three cases came from No. 7 room, a room from which two cases at least had been admitted in the Essex Regiment within the preceding six weeks. Is it a mere coincidence that six men should be admitted from the same four rooms as had furnished seven cases in another regiment during the few weeks immediately preceding?

The other company that showed a relatively large number of admissions after arriving at St. Elmo was H Company; seven cases occurred between July 11 and the end of September; they were admitted from the four rooms, Nos. 10 to 13 in the upper storey; two of these came from the same room, No. 12, on September 22 and 25 respectively. These rooms had been occupied between May 8 and July 8 by F Company of the Essex Regiment, which had arrived from Gozo on May 8, and did not show any especial prevalence during its stay at St. Elmo; shortly after arriving at Imtarfa, however, three cases occurred, on July 13, 24, and 28, which had presumably contracted infection when staying in the rooms now mentioned.

With regard to the other group of cases, in C Company, the position may be stated thus: We have a body of men that have been living in Malta for rather over four months, and in that period have furnished two cases of Mediterranean Fever, apparently arising at two different places (Pembroke Camp and Corradino Prison), and with a month's interval between the two, the last admission having been six weeks since. This body of men now move into fresh quarters consisting of four rooms, just vacated by another group of persons, who have furnished 11 cases of fever during the year up to the date of leaving, seven having been admitted during the preceding three weeks. Out of the new company four are seized with the fever within six weeks. There is, I submit, a presumption that the infective agent is connected with the *place*. If this be considered a reasonable presumption, a further point to be noted is that the first admission amongst the fresh body of men occurred 20 days, and the second 22 days, after their arrival at the presumably infected barrack rooms, indicating an incubation period of about 21 days.

An examination of the incidence of Mediterranean Fever in these two bodies of men, the Essex and the Lancashires, so far indicates that the disease may prevail in a strictly localised fashion. Both these battalions have occupied old barracks with many sanitary defects; the next case to be considered is that of a battalion living in good modern barracks in a healthy situation.

§ 3.

The First Royal Dublin Fusiliers have occupied St. George's Barracks, Pembroke, since March, 1904; they arrived in Malta from South Africa in November, 1902; in February, 1903, five companies left for Crete and Cyprus, the remaining three being stationed at Imtarfa. At the beginning of March, 1904, the whole battalion came into St. George's. During 1904, only four cases of Mediterranean Fever occurred, one of which was contracted in Cyprus. Therefore, the battalion and the barracks were almost exempt from the disease during 1904. During the nine months, January to September, 1905, there have been 41 admissions. The different companies have suffered very unevenly, thus :—

A.	B.	C.	D.	E.	F.	G.	H.	Total.
13	6	5	3	8	2	3	1	41

It is seen that A Company has suffered most, with 13 cases; and H Company least, with only 1 case. In A Company there was a sequence of 5 cases between June 16 and July 6; and again a sequence of cases between August 16 and September 15; in D Company 3 cases occurred close together between August 16 and 30; and in E Company there were 3 cases between August 11 and 14, and again 3 cases between August 27 and September 10.

There is a noteworthy circumstance in connexion with the company incidence of Mediterranean Fever in this regiment: A Company, which had 13 cases, and H Company, which had only 1 case, occupy the same barrack block, lettered F; the companies are of the same strength; they each occupy seven barrack rooms; A Company having those in the eastern half, nearest the sea, and H having those in the western half. The two companies use the same cookhouse, the same ablution room, the same latrine and urinal. The barrack block is one of six single-storey buildings, and consists of 14 rooms, all alike, measuring 30 × 21 feet by 14 feet in height, and accommodating 13 men in each, with an allowance of 605 cubic feet per head. Although there are no openings in the sides of the rooms, the door and two windows at each end, and the roof ventilators, appear to provide sufficient means of entrance and exit for the free circulation of air; the rooms seem to be airy and well ventilated. There are also in each block six bunks for non-commissioned officers; these are placed back to back, with no through ventilation, and are certainly hot and stuffy; none of the fever cases in this company occupied any of these bunks; the sergeant, who was admitted on May 29, lived in A Block, Married Quarters. Though these barracks are not of the most modern type, I can find no fault

with their essential sanitary conditions; the cookhouses and ablution room are excellent, the drainage system is modern, and, with trifling exceptions, of good construction; the drains are kept in excellent order, and the sanitation of the lines carefully attended to. The one important sanitary defect is the scarcity of water for flushing purposes, leading to a foul state of the water latrines of occasional, or perhaps frequent, occurrence. As regards situation, nothing better could be desired; they form a complete contrast to Lower St. Elmo and Floriana Barracks, and the extremely objectionable places occupied by troops in Cottonera Lines. They are freely exposed to the air on all sides, with no habitations near, and in three directions are practically open to the sea. Complaint was made by some men occupying No. 14 room (the one nearest to the sea) of bad smells coming from the sewer outlet into the sea in this direction. With the existing scarcity of water for flushing purposes, no doubt the drain air is occasionally offensive and the sewage malodorous; but I do not think that any harm could result to the occupants of these barracks therefrom; the outlet is many hundred yards distant from any of the buildings.

There does not appear to be any condition affecting A Company that does not equally affect H Company, and as the latter has been immune to Mediterranean Fever throughout 1904 and 1905, to the end of September (with the exception of one case), the cause for the prevalence in A Company is not obvious. The drinking-water supply and the milk supply are common to the whole regiment; the milk has been boiled, not by companies separately, but by the master cook centrally for all; therefore, whether effectually sterilised or not it has been consumed in the same—boiled or unboiled—condition by all companies alike.

In these barracks, as in most of the older barracks in the island, it has been the practice to affix the accoutrement shelves to the walls of the rooms in a continuous line, and not to separate them from each other as far as the linear space will allow. It is the custom to arrange the bed-cots in symmetrical order, each under the shelf that holds the occupant's kit and accoutrements. The length of the shelf is 3 feet 5 inches, the width of the bed is 2 feet 5 inches; consequently, when the shelves and beds are so arranged, there is only a space of 12 inches between bed and bed. Although the occupants have each 605 cubic feet of air space in the room, they are not evenly distributed so as to get each one his fair share, his one-thirteenth part, of the total cubic space; but they are crowded together, with only a foot between each pair of beds. Now, whatever the *materies morbi* may be, if it be once introduced into a room arranged like this, infection from person to person will the more readily take place, the closer the men are crowded together. So that if we assume that there is a particulate *contagium*, capable of being conveyed from an infected to a non-infected

person, such an arrangement as now described would facilitate spread of the disease, when the *contagium* has been once introduced, or has been introduced in sufficient quantity. But until it has been introduced, the arrangement would have no effect. In the case of these barracks, in which the sanitary conditions are uniform and (except for aggregation of beds and scarcity of flushing water) satisfactory, this aggregation offers a plausible explanation of the *spread* of the fever, though not of its origin.

§ 4.

There are eight companies of Royal Garrison Artillery quartered in Malta, their total average strength for the first nine months of 1905 amounting, with the District Staff, to 1941 : in this body of troops there occurred 88 cases of Mediterranean Fever (besides seven cases contracted in hospital), giving a ratio of 45·34 per 1000. There was, however, considerable variation in the prevalence in the different companies, as shown in the following table :—

Royal Garrison Artillery.

	Strength.	Cases.	Attack ratio per 1000.
No. 1 Company.........	190	13	68·4
5 „	235	8	34·0
63 „	216	4	18·5
65 „	205	17	82·9
96 „	217	15	69·1
99 „	222	12	54·0
100 „	240	10	41·7
102 „	215	7	32·5
District Staff	196	2	10·2

The men of the Garrison Artillery in Malta are, as a rule, older and of greater length of service, than the average infantry soldier: a larger proportion also have already had foreign service. As to length of stay in the island, two of these companies (63 and 99) arrived in 1902, two (99 and 100) in 1903, and the other four in 1904; it is not unusual, however, for men to exchange from one company to another, and under present arrangements the companies do not move from station to station *as a body*, but change their *personnel* by individual reliefs. The two companies that have been longest in Malta show a great difference in their fever incidence, No. 63 having had 18·5 cases per 1000, and No. 96 having had 69·1 cases per 1000; Nos. 99 and 100 arrived together, and show a similar incidence, 49·5 and 41·7 per 1000; Nos. 1, 5 and 65 arrived together, but show an incidence very unequal, viz., 68·4, 34·0 and 82·9 per 1000: No. 102, which arrived three months earlier, only 32·5 per 1000. It does not appear that

length of residence in Malta can account for the great variation in this year's prevalence of the fever in the Artillery.

The variation, however, has a relation to the barracks in which the different companies have been quartered. Two companies have been stationed at St. Elmo, three companies at Tigne (with a detachment at St. George's for a part of the time), and three companies at Ricasoli; thus:—

Upper St. Elmo—		
No. 65	17 cases	82·9 per 1000
96	15 ,,	69·1 ,,
Tigne—		
No. 1	13 ,,	68·4 ,,
99	12 ,,	54·0 ,,
102	7 ,,	32·5 ,,
Ricasoli—		
No. 5	8 ,,	34·0 ,,
63	4 ,,	18·5 ,,
100	10 ,,	41·7 ,,
St. James Cavalier, etc.—		
District Staff	2 ,,	10·2 ,,

A portion of 65th Company has been accommodated in St. James Cavalier and Castille, but only one case of fever has occurred among the men of this detachment. All companies have from time to time sent detachments to the outlying forts and practice camps; two cases have occurred in such detachments from 65th Company, and one from 96th Company. If these be deducted from the St. Elmo figures the incidence on the troops stationed there will be lessened, but the disproportion between the different barracks will not be diminished; for out of the 10 cases in 100th Company, no less than five were apparently infected at outlying forts; and of the seven cases in 102nd Company two were similarly of outside origin. The numbers are too small to justify any important deduction, but it is certainly noteworthy that the companies quartered in Valletta have been much more severely affected than those at Ricasoli, those at Tigne occupying an intermediate place.

The barracks at Upper St. Elmo are not quite satisfactory, but are not nearly so bad as Lower St. Elmo, or St. James Cavalier; the chief points are—defective latrine and urinal arrangements, and the continual use of tents, which must lead to fouling of the ground. St. James Cavalier is a very bad barrack, overcrowded and impossible to ventilate, with insanitary latrine conditions owing to scarcity of water: Mediterranean Fever has not however been prevalent there. On the other hand the sanitary condition of Fort Ricasoli is, on the whole, satisfactory, except that the large barrack rooms are difficult to

ventilate: the situation of this fort is ideal; as is that of Tigne barracks, which last are in as good a state, sanitarily, as Ricasoli: the incidence of Mediterranean Fever has however been greater at Tigne. I am not able to trace any definite connexion between the degree of prevalence of Mediterranean Fever amongst the different artillery units and the respective sanitary conditions of the barracks in which the units were quartered.

The isolation of Ricasoli from all native surroundings is fairly complete: this may be said in a lesser degree of Tigne: but from Tigne the men habitually go to spend their spare time in Valletta, whereas from Ricasoli it is not, I am informed, at all common for the men to cross the Grand Harbour to spend their evenings in the town. Isolation (habitual though not complete) does not however prevent the occurrence of the disease, as 11 cases have occurred amongst men stationed in outlying forts and camps, the disease having apparently been contracted in these places. Though situated in the open country, and generally near the sea, so as to be airy and healthy, there are certain insanitary conditions present in nearly all these forts. From the necessity of the case the sleeping rooms are imperfectly ventilated, though I did not find that there had been any overcrowding anywhere, except at Benghisa. In most forts the water supply was scanty, leading to parsimony in its use for latrine and urinal flushing, where water latrines are provided. Dry earth latrines are, however, in general use; and, with some few exceptions, are kept in an insanitary condition. With a scanty water supply, a very imperfect method of removal of excreta, and a minimum amount of air space, or air change, in the sleeping rooms, the forts cannot be called sanitarily satisfactory; but as regards the general health of the men quartered in them, it appears to be excellent, in spite of these sanitary shortcomings. Two cases were admitted from Fort Delimara on the same day (August 10), and two cases from Ta Silch within a week of each other (September 6 and 13); in no other instance was there any apparent connexion between cases at any of the forts.

Three cases were admitted on three successive days, May 18, 19, 20, in No. 65 Company, from tents at Upper St. Elmo, but I was unable to ascertain if they had occupied the same tent. Two cases occurred out of eight occupants of the same room, No. 6 Lower Storey, in 96th Company, on March 23 and April 19. Two cases occurred in 99th Company in the same hut, No. 6; and two other cases also in the same hut, No. 8, at Tigne, within a fortnight of each other in September; there were 16 occupants in each hut. Within the space of 14 days in August three men were admitted from No. 1 barrack room, Ricasoli, in 5th Company, accommodating 33 men; and two men, out of five occupying a room at the Auberge de Castille, and employed at the Royal Artillery officers' mess, were admitted on

June 9 and July 29. What connexion there may have been between these cases is doubtful. No. 1 room at Ricasoli is especially difficult to ventilate; the room at the officers' mess is reported to be close and stuffy; the Upper St. Elmo rooms and the Tigne huts are sanitarily satisfactory.

§ 5.

There are two infantry battalions that have not suffered to any great extent from Mediterranean Fever during 1905, but which offer a contrast, the one to the other. The 1st Royal West Kent Regiment arrived in Malta on April 15, 1904, and after a month in camp at Pembroke and Mellieha were quartered in Floriana Barracks, where they have remained ever since, except for a month in camp in November and December, 1904, and again three weeks in March, 1905. One company however, B, was in camp at Ghain Tuffieha for three months from February 1 to May 1. During the nine months 37 cases of Mediterranean Fever were admitted from the battalion, the distribution by companies being as follows:—

A.	B.	C.	D.	E.	F.	G.	H.	Uncertain.	Total.
6	1	4	1	5	3	7	8	2	37

The barracks occupied by this regiment are of a composite character. Three companies have been quartered in the "Old Barracks," which are casemates of the type so common in Malta; these are especially difficult to ventilate, on account of their great length, which is about 80 feet; they have however not been overcrowded, as the battalion has not been up to full strength, and the cubic space has therefore been nominally sufficient; instead of 30 men, not more than 24 have generally occupied one room. It is however evident that an apartment 80 feet in length, with no lateral openings whatever, cannot possibly be supplied with a proper change of air by natural ventilation. Three companies have been quartered in the New Barracks, which consist of three separate two-storey blocks, constructed with every regard to the principles of modern sanitation; each room accommodates 26 men. One company has been quartered in Notre Dame Ravelin Barracks, a single storey building consisting of 16 small rooms, with five men in each; and one company has been divided between one room in the Old Barracks and two huts in the Ravelin; the band also occupy huts in the Ravelin; each hut accommodates 18 men. A small detached fortress, the Salvatore counterguard, accommodates a party of signallers, numbering 30.

The number accommodated in the Old Barracks is 360, in the New Blocks 318, in the Ravelin and Salvatore 245; total, 923. The distribution of cases of Mediterranean Fever has been thus:—

A, C, and G (Old Barracks)	17	cases.
B, E, and F (New Barracks)	9	,,
D (Ravelin)	1	,,
H (Old Barracks and Ravelin)	8	,,
Uncertain	2	,,
	37	,,

Three companies occupying the Old Barracks have had 17 cases; three occupying the New have had nine cases; one company occupying the Ravelin has had one case, and H Company, divided between the Old Barracks and Ravelin, has had eight cases. One case, however, in A Company was admitted, not from Old Barracks but from Notre Dame Ravelin (a bandsman); the one case in B Company, and one case in E, occupied huts in Ravelin, not the New Blocks; and one case in H was infected apparently in Pembroke Camp, not in the Old Barracks. Making these corrections it is seen that the admissions were as follows:—

From Old Barracks, accommodating 360	23
From New Barracks, accommodating 318	7
From N.D. Ravelin, &c., accommodating 245	4
From Pembroke Camp (1), Ghain Tuffieha (1)	2
Uncertain	1
	37

It seems evident that the incidence on the body of men occupying the Old Barracks is disproportionate, although the numbers are too small to afford much ground for drawing any decided conclusion. In two instances there seems to have been a likely connexion between cases; in A Company two admissions took place from No. 8 room, one on March 28, the other on April 10; in H Company three men were admitted from No. 3 room, on April 2, 9, and 24; the exact room that a man slept in is not ascertainable in every instance, although it is generally possible to localise the part of the barracks occupied with some accuracy. It is quite clear that the battalion, as a whole, did not suffer uniformly, but that there was a prevalence amongst some groups of men, or in some portions of the barracks.

§ 6.

The 2nd Hampshire Regiment has furnished fewer cases of Mediterranean Fever during the period under consideration than any other regimental group: there have been 27 cases in a strength of 997 men. They arrived in Malta on September 16, 1903, and have remained in

Verdala Barracks all the time, with short yearly absences in camp. A portion of the battalion has occupied some of the smaller barracks in Cottonera Lines (Polverista, St. Clement's, etc.), but no especial difference is observable in the incidence of the fever upon these different detachments, the ratio for the whole battalion being 27 per 1000, and for the Verdala portion 29·1 per 1000. The cases occurred sparsely throughout the year, not more than six occurring in any one month (September), and no company contributing more than four; in only one instance has there appeared to be any connexion between one case and another: a man was admitted from Zabbar Gate on July 6, and another from the same place on July 15.

The general sanitary condition and surroundings of Verdala and the Cottonera Lines are certainly not better than those of Floriana, and in one important respect, that of scanty water supply for flushing purposes, they have been much worse off; the small casemate rooms in Verdala are, however, much better ventilated than the large casemates in Old Floriana Barracks.

The 2nd Royal Sussex Regiment arrived in Malta from England on June 27, 1904, and were quartered in Polverista and other barracks in the Cottonera Lines. They were in camp at Pembroke and Mellieha, four companies at a time, for a month in November and December; and the whole battalion together at Ghain Tuffieha for a fortnight in January, 1905. They marched up to Imtarfa on February 22 and 26, and on May 29 five companies, with the headquarters, left for Crete. During 1904 they suffered little from Mediterranean Fever, having had only 11 admissions altogether; up to the departure of the five companies to Crete at the end of May, there had been 17 admissions during 1905; these cases had been scattered about in different companies and barracks, and there was no particular incidence on any one company or barrack. Between June 26 and August 24 there were five admissions from C Company, all from the same barrack block (H), and two from the same room (No. 97), on August 4 and 10; from this room also another man was admitted on September 21. H Company occupies the other half of H block, from which four other cases were admitted between April and September, but no two from the same room. The rooms vary in size, some accommodating 16 and some 20 men; No. 97 accommodates 20 men.

§ 7.—*Hospitals.*

The total number of cases of Mediterranean Fever that apparently contracted the disease in hospital, either as patients admitted for some other illness and subsequently developing this fever under circumstances pointing to hospital infection, or as non-commissioned officers and men of the Royal Army Medical Corps, and other men attached

for nursing duties, amounted to 56. Of this number 33 occurred at Valletta Hospital, 17 at Cottonera. The accompanying table shows the distribution in detail. It is seen that, in all, 23 patients in hospital contracted the disease, 30 R.A.M.C., and three men attached for nursing duties :—

——	Average number of patients.	Average number R.A.M.C.	Cases of Mediterranean Fever.		
			Patients.	R.A.M.C.	Men attached.
Valletta	157	74	11	19	3
Cottonera	102	45	10	7	—
Forrest	47	10	1	2	—
Citta Vecchia...	47	15	1	2	—
Imtarfa	25	8	—	—	—
Gozo	2	3	—	—	—
	380	155	23	30	3

The total average hospital population, including patients and orderlies, amounted to 535, amongst whom there occurred 56 cases of Mediterranean Fever, being in a ratio of 104·66 per 1000. Of these, 23 occurred in an average population of 380 patients, being in a ratio of 60·53 per 1000; and 30 in an average population of 155 orderlies R.A.M.C., or, 193·55 per 1000. While the incidence is decidedly greater on the men of the R.A.M.C., this varies in the different hospitals; thus at Valletta the ratio among the patients was 70·1, among the R.A.M.C. 256·8 per 1000; at Cottonera, among the patients 98·0, among the R.A.M.C. 155·6 per 1000. The incidence upon the patients is not, however, fairly comparable either with that upon the R.A.M.C., or with that upon any of the regimental units that have been previously considered; because the hospital *sick population* is constantly changing. The R.A.M.C. prevalence can be fairly compared with that of any other unit, and the severity of the outbreak amongst this body of men is immediately evident. The highest ratio in any regimental unit is that of the Essex Regiment, 88·33 per 1000: and for any barracks, that of Lower St. Elmo, 137·03 per 1000; for the R.A.M.C. as a whole the ratio is 193·5, for those quartered in Valletta Hospital 256·8, for those at Cottonera Hospital 155·6 per 1000.

The incidence upon the patients at Valletta Hospital, 70·1 per 1000 was less than that upon the Essex Regiment; at Cottonera the patients suffered more, viz., 98·0 per 1000; but these ratios are not properly comparable, as just mentioned.

The circumstances that lead to the opinion that the infection was contracted in hospital in the following instances will now be shortly stated, beginning with the sick under treatment for other forms of illness :—

Case 1.—Private Minter, Essex Regiment, was admitted from Lower St. Elmo to Valletta Hospital on February 14, with "gonorrhœa" ; on March 25 he was transferred to Forrest Hospital; his "disease" was changed to Mediterranean Fever on April 20; it is almost certain that infection was contracted in one or the other hospital, more probably in Valletta than in Forrest.

Case 2.—Private Salmon, Rifle Brigade, was admitted to Valletta Hospital for "debility" from Manoel Hutments, on March 24, 1905. He was treated in 20 A Ward. He was transferred to Citta Vecchia Sanatorium, April 17; and discharged to duty at Manoel, May 1. He was again admitted to Valletta on May 14, having been ill for about 10 days. His illness commenced in the first week of May, and was contracted either in Valletta or Citta Vecchia Hospitals, most probably in the former.

Case 3.—Gunner Jardine, R.G.A., was admitted to Valletta Hospital from Upper St. Elmo suffering from "orchitis" on April 3; he was transferred to Citta Vecchia on May 22, and the "disease" changed to Mediterranean Fever on June 1; his infection was almost undoubtedly contracted in Valletta Hospital.

Case 4.—Gunner Moore, R.G.A., was admitted to Valletta Hospital from Upper St. Elmo with "gonorrhœa" on April 7; his "disease" was changed to Mediterranean Fever on June 13, after more than two months' stay in hospital, during which time he must have taken the infection.

Case 5.—Private Bush, Essex Regiment, was admitted from Lower St. Elmo to Valletta, suffering from venereal disease, on May 24; on June 6 he was transferred to Cottonera, and on June 26 began to be ill with Mediterranean Fever; the infection was probably contracted within the preceding 33 days, *i.e.*, after his admission to Valletta Hospital; but it is uncertain whether at Valletta or Cottonera; moreover, Mediterranean Fever was prevalent at Lower St. Elmo in May. This is a doubtful case of hospital infection.

Case 6.—Private Potter, Rifle Brigade, was in Valletta Hospital with venereal disease from May 16 to June 7, when he was discharged to St. Andrew's Barracks. He was admitted to Forrest Hospital on June 29, suffering from Mediterranean Fever, having been ill for about one week before this; it is more probable that he took infection in Valletta Hospital before June 7, than in St. Andrew's Barracks between June 7 and 22; these barracks had just been completed and taken into occupation on June 2.

Case 7.—Private Gerard, Rifle Brigade, was admitted to Valletta from Ghain Tuffieha Camp on May 14, suffering from gonorrhœa; on July 1 Mediterranean Fever was diagnosed; infection was almost certainly contracted during the preceding six weeks in hospital.

Case 8.—Private Wilding, Rifle Brigade, was admitted to Valletta, 20 A Ward, from Manoel on May 30, with enteric fever; on July 16 he was found to be suffering from Mediterranean Fever and the "disease" was changed; infection was probably contracted during the preceding 46 days in hospital; unless it be supposed that a double infection had been contracted originally, and that the enteric symptoms and agglutination phenomena had masked those of Mediterranean Fever.

Case 9.—Gunner Marjerum, R.G.A., was admitted to Valletta on July 29, with Mediterranean Fever, having only been discharged from the same hospital 10 days before, during three or four of which he was sickening with the fever; he

had previously been under treatment in 20 B for six weeks (gonorrhœa), and in this period probably contracted the infection.

Case 10.—Private Heaton, Lancashire Fusiliers, was admitted to Valletta from Lower St. Elmo on August 1, with Mediterranean Fever, having already been ill a few days. From June 28 to July 15 he had been in the same hospital, treated for "debility," but without any symptoms of Mediterranean Fever. It is more probable that infection was taken during the fortnight before than during the fortnight after, July 15; but the case is an uncertain one. The battalion had moved from Cottonera Lines to Lower St. Elmo on July 11; several cases of fever had occurred, but not in this man's company, about that time.

Case 11.—Private Keylock, Hants Regiment, was admitted to Valletta Hospital with gonorrhœa on July 29; he was discharged on September 1, and readmitted, suffering from Mediterranean Fever, on September 15. It is almost certain that he contracted the infection during his stay in hospital.

Case 12.—Private Collins, Hants Regiment, admitted to Cottonera March 23, 1905, suffering from enteric fever, as shown by serum reaction; serum reaction was negative to Mediterranean Fever, March 27 and April 29, but positive on May 1, when he had been in hospital 38 days; infection was therefore probably contracted in hospital, though conceivably along with the enteric infection before admission.

Case 13.—Private Bishop, Hants Regiment, admitted from Verdala to Cottonera, March 30, with scarlet fever; was isolated in No. 12 Ward from this date until April 26, when he was transferred to No. 5 Ward, where he remained until discharge on May 2; was readmitted May 10, and diagnosis made of Mediterranean Fever on May 15. His illness came on suddenly on May 9, and was almost certainly contracted between March 30 and May 2, while he was in Cottonera Hospital.

Case 14.—Gunner Abbott, 65th Company, Royal Garrison Artillery, was admitted from Upper St. Elmo to Cottonera, May 16, and placed under observation for mental disease. After being in hospital under close observation for 30 days symptoms of Mediterranean Fever developed, and the diagnosis was made on June 21. The length of sojourn in hospital before onset of fever symptoms points to infection contracted within the hospital precincts. It is to be noted, however, that three men in 65th Company were admitted with Mediterranean Fever on May 18, 19, and 20 (having presumably been ill a few days before, and conceivably infectious); and that other admissions from the same company for this disease took place on June 1, 3, 16, 19, and 20; infection was therefore present in this company in Upper St. Elmo.

Case 15.—Private Haines, Hants Regiment, was admitted from Verdala to Cottonera, No. 10 Ward, with "abscess," on April 21; Mediterranean Fever was diagnosed May 19; there were fever cases in No. 10 Ward at the time of his admission; it is more probable that infection was taken during the 29 days' sojourn in this ward than in Verdala Barracks previous to admission; in these barracks one case only had occurred in March, one in April, and none in May.

Case 16.—Gunner Duncan, 63rd Company, R.G.A., was admitted from Ricasoli to Cottonera, No. 1 Ward, with gonorrhœa, on April 4; on May 22 Mediterranean Fever was diagnosed. This was almost certainly contracted during his preceding seven weeks' sojourn in hospital. Only one case of fever occurred at Ricasoli (February 3) during the first four months of the year.

Case 17.—Private Knight, Hants Regiment, was admitted from Couvre Porte to Cottonera, No. 1 Ward, on March 28, with gonorrhœa. Mediterranean Fever was diagnosed on May 23, seven weeks afterwards. Infection was almost certainly contracted in hospital.

Case 18.—Private Wilkinson, Lancs. Fusiliers, was admitted from Żeitun Barracks to Cottonera, No. 1 Ward, with gonorrhœa on March 3: the first symptom of fever was felt about June 3, and the diagnosis made on June 13. Infection certainly contracted in hospital.

Case 19.—Private Shortland, Hants Regiment, was under treatment in Cottonera Hospital for gonorrhœa from April 26 to June 3. On June 20 he fell ill, and was admitted on 21st, suffering from fever, which was diagnosed on 29th. The shortest incubation period may probably be considered to be about 14 days; he might have contracted infection, therefore, in the three or four days immediately after his discharge from Cottonera on June 3; or while in hospital during the previous fortnight. Four cases were admitted from Verdala Barracks in June, one being from the same company as Shortland; there had been no admissions in May; during this month and the early part of June, when he presumably contracted infection, there were 20 or more cases of Mediterranean Fever in Cottonera Hospital, which was therefore a more likely source of infection than Verdala Barracks.

Case 20.—Gunner Taylor, 99th Company, R.G.A., was under observation for mental disease in Cottonera Hospital from June 2 to 20; he was readmitted with fever on June 29, and Mediterranean Fever was diagnosed July 7. It is more likely that infection was contracted between June 2 and 20, than between June 20 and 29; or before June 2.

During July and August no cases of Mediterranean Fever appear to have arisen among the patients at Cottonera, though four orderlies of the R.A.M.C. were attacked.

Case 21.—Private Smith, Royal West Kent Regiment, was in the hospital from June 27 to July 5, and from July 7 to August 5, suffering from wound of foot: during the latter period he was in No. 1 Ward. He was readmitted with gonorrhœa on August 11. He first felt ill with fever on September 3, and Mediterranean Fever was diagnosed on September 9. He might have contracted the infection during his brief residence in Floriana Old Barracks between August 5 and 11; or in hospital during the 24 days immediately preceding the onset of his illness, when he was in No. 1 Ward, in which were Mediterranean Fever patients. Floriana Old Barracks suffered from fever earlier in the year, but no case was admitted from them between July 24 and August 28.

Case 22.—Private Palmer, Essex Regiment, was transferred from Valletta to Citta Vecchia Sanatorium on December 19, 1904, suffering from hernia; on February 2, 1905, his "disease" was changed to Mediterranean Fever; the date of onset is not certain, but the probabilities are that infection was contracted in hospital, either at Citta Vecchia or Valletta.

Case 23.—Gunner Haynes was admitted to Forrest Hospital from Tigne on May 12, with enteritis, and was transferred to Citta Vecchia on August 16; on September 1 his "disease" was changed to Mediterranean Fever; the blood had reacted before leaving Forrest, and infection was, without doubt, contracted there.

Of the above 23 cases it may be affirmed that 16 almost certainly became infected in hospital; Cases 5, 6, 10, 14, 19, 20, and 21 are doubtful: but in my opinion the probabilities are much in favour of hospital infection in all the cases except No. 5 (Bush), 10 (Heaton), and 14 (Abbott), in which the uncertainties are considerable. Of the 11 Valletta cases, eight were venereal patients treated in 20 B Ward; Salmon and Wilding had been inmates of 20 A Ward; in the case of

Heaton, who had been under treatment for debility, the ward is uncertain. Of the 10 Cottonera cases, four venereals and one other (Smith) had been treated in No. 1 Ward, two (Abbott and Taylor) had been in observation wards, two (Collis and Haines) in the "fever wards," and one (Bishop) in No. 5 Ward. Therefore, 10 out of the 11 Valletta cases had been inmates of the same apartment (albeit a very large one) as was occupied by patients suffering from Mediterranean Fever: and 3 out of the 10 Cottonera cases had, in the same way, been treated in the wards along with the Mediterranean Fever patients.

Of the 19 cases amongst N.C.O.'s and men of the R.A.M.C. at Valletta Hospital, the following were brought into intimate association with the Mediterranean Fever patients, being employed in the fever wards, either as nursing, or as general duty, orderlies: Elsey, Brooks, Smith (14,901), Bowden, McGill, Smith (19,123), McConaghey, Whitmore, Aldous, Hardless, Playle: 11 in all. The following were not employed in these wards, and did not come into any continued or close association with the fever patients. Q.M.S. Dudman, Brown (clerk), Farr (cook), Sergeant Dewberry (laboratory), Corporal Hughes (day wardmaster, not in fever wards), Corporal Woods (pay office), Robinson (P.M.O.'s clerk), Q.M.S. Bridges: eight in all. Of these eight men it may be said that not only were they not brought into any special contact with fever patients, but that they had absolutely nothing to do with them, either directly, or indirectly (except the two quartermaster-sergeants). These two non-commissioned officers had certain duties in regard to the clothing and bedding of the patients that would constitute an indirect connexion. Sergeant Dewberry was specially employed as assistant in the laboratory of the Mediterranean Fever Commission; there can be little doubt that it was in this occupation that he contracted the disease.

All the corporals and privates of the R.A.M.C. sleep in the same barrack room, No. 31 (with an adjacent bunk); this is a large apartment, 96 feet long by 31 feet wide, the side annexe being $28 \times 17\frac{1}{2}$ feet. The room is well lighted, and airy in appearance, but on account of its extreme width and the absence of through cross ventilation (the annexe and two sergeants' rooms adjoining it on one side), it is difficult to secure a satisfactory change and renewal of the contained air. The height is 20 feet in the main room, and 15 feet in the annexe. The accommodation is authorised as for 54, giving an average cubic space of 1238 cubic feet per head; or, reckoning the height at 12 feet, of 770 cubic feet per head. The room has been full throughout the year, but not overcrowded in the hot weather, as many of the men sleep out on the roof, or on the verandah. The three men attached to R.A.M.C. for duty also slept here. Of these, two (Davis and Franklyn) were employed in the female hospital in general duty work. Cases of

Mediterranean Fever have been under treatment in this hospital throughout the year, but the orderlies were not brought into direct association with them in any way.

Of the seven cases occurring amongst R.A.M.C. at Cottonera Hospital, five were employed in the Mediterranean Fever wards; the other two, Rogers and Miller, were both employed in the hospital kitchen; part of their duties being to supervise the milking of the goats; they also took their turn of general night duty.

The two cases of R.A.M.C. at Citta Vecchia had both been employed in attendance on convalescent Mediterranean Fever patients, of whom there have been a large number at this hospital throughout the greater part of the year.

At Valletta Hospital four ladies of Queen Alexandra's Imperial Military Nursing Service have been employed in nursing duties. Of these, one has suffered from Mediterranean Fever during the past year. At Cottonera there is also a staff of four, and during 1904 and 1905 six nursing sisters have been attacked; four cases occurred in June and July, 1904, and two in January, 1905. At the Military Families Hospital, which is situated alongside of the military hospital, Valletta, the head nurse was placed on the sick list with Mediterranean Fever on June 20, 1905. All these ladies have been engaged in attendance on patients suffering from the disease, and have, therefore, been brought into intimate contact with them. At Valletta the sisters live in the hospital quadrangle. At Cottonera there are sisters' quarters in a detached house in the hospital grounds. It has been the practice until July, 1905, to milk the goats that provide milk for the patients on a plot of ground within a few yards of these quarters; and there is no doubt that this area was extensively fouled every day for a long period. No cases have occurred amongst the sisters at Cottonera during the summer, since the goats were removed from this spot.

§ 8.—*Women and Children.*

During the period under review there have been, as far as I have been able to ascertain, 38 cases of Mediterranean Fever amongst the families of the troops, 27 of which have been women, and 11 children. The exact number of the population from which these cases were derived is not yet available; but probably varied little from that of the preceding year, when there were 567 women and 928 children present in Malta (belonging to the garrison) on an average. The cases occurred all over the island, and there was no particular prevalence in any one group of quarters.

Allusion may be made in this place to the very remarkable prevalence of Mediterranean Fever in the New Misida Married Quarters in 1904. These quarters accommodate 44 families; A Block was completed and

taken into use in 1903, B Block in 1904. A study of the cases shows that there were 12 cases in 44 families, of which nine at least occurred in the 24 families occupying A Block. Twelve of these quarters are on the ground floor, and 12 on the upper floor; one of the cases occurred in No. 3 on the ground floor, and eight cases occurred in the 11 quarters on the upper floor. All the adjoining quarters were affected, from Nos. 14 to 19 at the north-east end of the block; Nos. 20 to 24 were unaffected, and in B Block to the south-west, there were two cases only amongst 20 families. It is uncertain whether Sergeant Biltcliffe lived in A or in B Block.

During the year 1904 there were, according to the Annual Sick Return, 109 cases of Mediterranean Fever amongst the women and children of the garrison. I have only been able to trace records of 67 of these, viz., 42 women and 25 children; the remainder were probably treated in quarters, and as to the diagnosis, I am unable to offer any opinion. Without attempting any statistical statement as to the prevalence in the various married quarters, it is certainly the case that nowhere else was there such an alarming incidence as in this particular block of buildings.

There are not many instances in which more than one member of the same family has been attacked. The following are all that I have been able to ascertain as occurring during 1904 and 1905. In the Misida quarters, Floriana, Mrs. Sanders was taken ill in July, 1904, and Colour-Sergeant Sanders was admitted on August 30; Sergeant Rogers was admitted September 21, and Mrs. Rogers on December 13; Mrs. Westbrook was placed on the sick list on October 2, 1904, and a child on January 23, 1905, the mother having a relapse a few weeks later.

At the Camerata married quarters (where about 90 families are in occupation) only one instance has occurred lately: Staff-Sergeant Lowe was taken ill in September, 1904 (presumably infected in hospital), and Mrs. Lowe in October. At St. Francis Ravelin Corporal Sullivan was admitted on July 13, and his child fell ill very shortly after. Two children in the family of Sergeant Hammett were attacked in 1904, one in June, the other in October. At Valletta Hospital, the wife of Quartermaster-Sergeant Bridges was admitted on May 27, 1905, the child on July 28, and Sergeant Bridges himself on August 11. Quartermaster-Sergeant Dudman was admitted on January 8th, 1905, and Mrs. Dudman on July 17. Conductor Fasson and Mrs. Fasson, living at Sliema, were placed on sick list on April 23 and May 9 respectively. The wife of Captain Challoner, living at Sliema, was first taken ill in November, 1903; the illness continued until May, 1904; on July 1 her son sickened, and a fortnight later her daughter. The wife of Major Preston, also living at Sliema, was attacked in the middle of January, 1905; her sister, and an English maid, were

both taken ill about four weeks later; Gunner Hardy, a soldier servant living in the house, was admitted to hospital on April 18.

In some of these cases some common condition was most probably the cause of the attack in both man and wife, or parent and child; but where an interval of several weeks elapses between the attacks, the likelihood of direct infection must be borne in mind. But as pointed out by Dr. Johnstone in his Report of last year (p. 38), if direct infection were always an important factor in the spread, it would be expected that a large proportion of multiple attacks in families would occur, and this has not been the case.

Section III.

From the foregoing account of the mode of prevalence, or behaviour, of the Mediterranean Fever epidemic during the first nine months of 1905, it may now be possible to gather some outstanding facts that will help either (1) to indicate the mode, or modes, of spread of the infection; or, if this is not evident, or probable, then (2) the conditions that assist in the spread of the disease may be ascertained, or shown to be probable.

§ 1.

It has been shown (1) that Mediterranean Fever has appeared in all the barracks in the islands, in which are quartered any considerable body of men (say one hundred or more).

(2) Although the disease has been universal throughout the garrison, the barracks have been affected very unevenly, Lower St. Elmo having had an attack ratio of 137 and Ricasoli of only 23 per 1000. The highest incidence has occurred in Valletta Hospital, 143 per 1000; Lower St. Elmo, 137 per 1000; Cottonera Hospital, 116 per 1000. These three places have suffered far more than any others, Upper St. Elmo having only had 66 admissions per 1000, and all the other barracks being less affected (mostly between 40 and 60), until at the bottom of the list come Verdala (27), Ricasoli (23), and Ghain Tuffieha Camp (8 per 1000).

(3) All the different bodies of troops have suffered, except such small parties as the Military Foot Police (numbering 16), and the Mounted Infantry Staff (numbering 11); and one battalion of over 500 strength, but which left the island in March (K.O. Yorkshire Light Infantry).

(4) The variation in prevalence has been equally well marked in the case of different bodies of men, as in the case of different barracks. The Royal Army Medical Corps suffered to the extent of 193 per 1000; the Hampshire Regiment had only 26 admissions per 1000. After the R.A.M.C. the Essex Regiment suffered most, 88 per 1000; four other infantry battalions and the Royal Artillery had between 43 and 54,

while the Royal Engineers had only 33, and the Hampshire Regiment only 26 per 1000.

(5) Although the total number of admissions for Mediterranean Fever increased in March, and again very markedly in May, remaining with little variation at a high level throughout the rest of the summer, this was not the case uniformly throughout the island; the maximum prevalence differing in different barracks; *e.g.*, in Lower St. Elmo it was in June, at St. George's in August, and at Cottonera in July.

(6) On examining more closely into the prevalence of the disease in different regiments it is found that there is a considerable unevenness of incidence on different groups, *i.e.*, companies, occupying the same barracks, and living under apparently almost identical conditions. For instance, in the Essex Regiment, G and H Companies had each 19 cases; of these 38 cases, 21 occurred between May 8 and July 8; alongside of them, and living under the same conditions in every way, were D and F Companies; no case at all occurred in D, and only one in F Company, during this period. The difference (or, *a* difference) between the two bodies was, that G and H had been living in Lower St. Elmo all the year, while D and F had been at Gozo until May 8. Again, from the four barrack rooms in the middle storey, Nos. 9 to 12, there were admitted 16 cases up to the departure of the regiment on July 8; from rooms Nos. 9 to 12 on the upper storey, accommodating the same number of men (about 90), there were admitted in the same period only six cases; in the former case the rooms were occupied throughout the whole time by H Company; in the latter the rooms were occupied by E Company up to May 6, who then went to Gozo, their place being taken by F Company, from Gozo. Sixty-four cases have occurred in the four companies that have been all the time at Lower St. Elmo and Imtarfa, 17 cases in the other four companies that have been part of the time at Gozo, as well as at St. Elmo and Imtarfa. The great prevalence in the Essex Regiment appears to be connected with residence in Lower St. Elmo barracks, and especially with certain rooms in those barracks.

(7) The Lancashire Fusiliers took the place of the Essex in Lower St. Elmo on July 11; after this date seven cases occurred in C Company, which occupied the rooms vacated by G Company of the Essex, the company that had suffered severely in the earlier part of the year. In H Company of the Lancashires, seven cases occurred after arrival at St. Elmo; they occupied the same rooms as F Company of the Essex, a company which had arrived from Gozo in May, and had suffered little; but shortly after their arrival at Imtarfa they had three cases (presumably contracted while living in these rooms at St. Elmo); local infection seems not unlikely. The other companies of the Lancashires suffered little.

(8) The Dublin Fusiliers have occupied St. George's Barracks since

March, 1904; all the companies are living under precisely similar conditions; out of 41 admissions for Mediterranean Fever during the nine months, A Company has had 13 and H Company has had only one: these two companies live in the same barrack block, use the same cookhouse, latrine, urinal, and ablution rooms; they are of the same strength; yet one has had 13 cases, the other only one.

(9) The eight different companies of the Royal Artillery have suffered very unevenly; No. 65 Company has had 83 per 1000 admissions, No. 63 company only 18·5 per 1000. The two companies stationed at Upper St. Elmo have had many more cases in proportion than the three companies at Ricasoli; Upper St. Elmo has had a greater incidence than any other barrack except the adjoining Lower St. Elmo; Ricasoli has had the lowest incidence of any barrack.

(10) The Royal West Kent Regiment, occupying Floriana barracks, have not suffered severely; they furnish another example of an uneven, and limited, prevalence; of 35 total admissions the origin of one is uncertain; as to the remaining 34, the *Old* Barracks (accommodating 360) contributed 23, the remaining 11 coming from the *New* Barracks, Ravelin, etc. (accommodating 563).

(11) The ratio of incidence on Hospital populations, reckoning patients and attendants together, is high, 104·7 per 1000, but not so high as among the troops at Lower St. Elmo (137 per 1000); at Valletta Hospital, however, it is 143 per 1000, Cottonera showing 116 per 1000, and the smaller hospitals much less. The attendants, taking all the hospitals together, suffer much more (193·5 per 1000) than the patients (60·5 per 1000); but the incidence upon the patients is not fairly comparable, as they are a very fluctuating population. Taking the two large hospitals, the incidence upon the orderlies of the R.A.M.C. is 257 per 1000 at Valletta, and 156 per 1000 at Cottonera, both figures being considerably higher than in any other body of troops.

(12) There has been no great prevalence of Mediterranean Fever amongst the married families during the period under consideration, though cases have occurred everywhere throughout the married quarters. In comparatively few instances have two or more members of a family been attacked under circumstances indicating direct infection from one to the other. There has been no recurrence of the remarkable outbreak of 1904 in one particular set of newly-built married quarters (Misida Bastion), which seemed to point so strongly to some strictly localised condition.

§ 2.

We may now consider what information can be obtained from the foregoing account of Mediterranean Fever prevalence in 1905, as to its probable mode of spread. Infected water, infected food, infected air,

are the three most obvious possible channels of conveyance; these may be first dealt with.

i. *Infected Water.*—The water supply of Malta has been sufficiently described in Dr. Johnstone's Report. So far as concerns the military population, there are no barracks in which there is not an ample supply of drinking water of good quality (known as No. 1 Water), in every case laid on direct from the main, and therefore free from any danger of local contamination. The same water is supplied to all the barracks. It is inconceivable that with such a supply, and such a method of distribution, there should be a prevalence characterised by the special features that have been above noted, if the drinking water were the channel of conveyance. Although it is the case that another quality of water is also supplied for ablution purposes, which is not so pure, and which therefore might be thought to be a carrier of infection, this is in the highest degree improbable. Everywhere the taps supplying this water are marked, "Not for drinking," and everywhere the pure supply is quite as readily obtainable as this ablution water. Careless as the soldier may be about his health, he is not such a fool as to drink water marked "unfit," when there is a tap of good water alongside; such a case might occur very exceptionally, but not as a common practice. Moreover, in barracks that are supplied *only* with No. 1 water, such as St. Andrew's and Tigne, and in married quarters, such as the new Misida blocks at Floriana, Mediterranean Fever has prevailed more extensively than in some other places, such as Verdala and Imtarfa, which have a double supply. As was pointed out by Hughes, if the inferior water supply were the channel of conveyance, "we should expect the inhabitants of private houses in the same area supplied only with the good water to be immune from [Mediterranean] fever; but this is very far from being the case."

The use of *ice*, and of *aërated waters*, is really to be considered along with the question of water supply. During the summer months the use of ice is universal amongst those that can afford it; few people in comparison drink plain water; nearly everyone drinks aërated water and ice; if any particular parcel of ice were infected there could hardly fail to be an explosive outburst of the fever, analogous to a water epidemic. There is no evidence to this effect, and no suspicion seems ever to have been excited that such was the cause. So with lemonade, soda water, and other aërated drinks that are consumed by everyone in the hot weather, there appears to be no evidence whatever incriminating these articles.

§ 3.

ii. *Infected Food.*—The two articles of food that appear to be the most likely channels are *milk* and *uncooked vegetables*. With regard to the latter, I regret that I have no evidence whatever: the methods of

cultivation in vogue in Malta would lead one to look upon all uncooked vegetables as dangerous articles of food. Human excrement is largely used as manure, and one would regard lettuces, tomatoes, radishes, and all vegetables eaten in the way of salad—*i.e.*, uncooked, also certain fruits, such as strawberries, with great suspicion. There is a fairly general consumption of such articles by the people who can afford to buy them; but by the troops they are hardly eaten at all. It is a failing of the British soldier that has been frequently commented on, that he does not take advantage of the vegetable food that is available, wholesome, nourishing, and cheap, in the different parts of the world in which he serves. He has no culinary instinct, he cannot dress vegetables, and he cannot make a salad. Such things do not form part of the men's ordinary food, nor, as far as I have been able to ascertain, are they an article of consumption in the regimental coffee shops and supper bars, or in the eating-houses frequented outside barracks.

§ 4.

The question of the conveyance of *milk* is one of great importance, on account of the discoveries recently made as to the existence of Mediterranean Fever in goats, and the presence of *Micrococcus melitensis* in milk of apparently quite good quality, and yielded by goats in apparently perfect health.

The facts bearing upon this question now to be related fall under three heads: (1) The conditions as to milk supply of the different bodies of troops in Malta: (2) the conditions as to milk supply of the married families, and the prevalence of Malta Fever amongst them; (3) evidence as to milk consumption by Malta Fever patients.

(1) *Conditions of Milk Supply amongst the Troops.*

The procedure adopted in the different regiments has been as follows:—

Royal Garrison Artillery—Upper St. Elmo: 65th and 96th Companies. —Only condensed milk is used; no goats at all come into the fort, except one or two for the married people occupying the two married quarters.

Tigne: 1st, 99th, and 102nd Companies.—All milk used by the troops is tinned milk, except at the sergeants' mess, where it seems that a small quantity of goats' milk has been used.

Ricasoli: 5th, 63rd, and 100th Companies.—All milk used by the troops is condensed milk; one or two goats come into the fort for the married families.

Outlying Forts.—Only condensed milk is used.

This custom of using condensed milk is, in Malta, almost peculiar to the Garrison Artillery; it is probably due to the fact that a great

number of the men have had considerable service in India, where the milk is, speaking generally, of obviously poor quality from a housekeeper's point of view, and lies under a very widely-held suspicion of impurity from the medical standpoint, chiefly in regard to enteric fever. This is now a matter of general knowledge amongst the troops in India. Condensed milk is now of such good quality, and so cheap, that the Artillery and their families use it, almost without exception, and are well satisfied with it. In the outlying forts, where the arrangements and supervision are less complete, goats' milk may be occasionally used; but I think it must be of rare occurrence, because amongst the Artillery the feeling is, and for a long time has been, decidedly in favour of condensed milk; the kinds used are Milkmaid brand and Nestlé's.

The *Lancashire Fusiliers* have used goats' milk. Since arrival at Lower St. Elmo on July 11 no goats have been allowed inside the fort, except one or two for married families. The goats have been milked outside, morning and afternoon, the milk brought to the regimental cookhouse and immediately boiled, under the supervision of the master cook.

The *Royal Sussex* Regiment at Imtarfa use only condensed milk.

The *Hampshire* Regiment (at Verdala) use goats' milk; the goats are milked outside the barracks; the milk is brought to the cookhouse and boiled.

The *Essex* Regiment use goats' milk. When at Lower St. Elmo no goats were allowed inside the fort, except one or two for the married families. The goats were milked outside, the milk brought into the regimental cookhouse, and boiled under the supervision of the master cook. The same arrangement is carried out at Imtarfa.

The *West Kent* Regiment at Floriana use goats' milk. The goats are milked outside the barrack gate. The milk is then taken to the various cookhouses (Old Barracks, Notre Dame, New Barracks), but it has not been boiled during the greater part of the summer.

The *Dublin Fusiliers* at St. George's use goats' milk. The goats are brought to the skittle-alley in the lines, and milked under the supervision of the master cook, who is then responsible that the milk is boiled in one of the company cookhouses. It is all boiled together. The skittle-alley is cleaned out daily.

The *Rifle Brigade* at St. Andrew's use goats' milk. The goats all come to one cookhouse, and are milked under the eye of the master cook, who then sees that the milk is boiled. One or two goats are sent up to the married quarters.

At *Valletta Hospital* the goats are milked under supervision in the paved back entrance to the lower square. The milk is "Pasteurised" in an Aymard steriliser.

At *Cottonera Hospital* the goats are milked under supervision in a

specially selected place. The milk is "Pasteurised" in an Aymard steriliser.

At Forrest, Imtarfa, Citta Vecchia, and Gozo Hospitals the milk is boiled.

The rule has been to boil, or Pasteurise, all milk throughout the garrison, with the exception of the West Kent Regiment and the Royal Artillery; the last named have used only condensed milk. As regards hospitals, this rule has been in operation for the whole of 1905 and most part of 1904. As regards troops, it is difficult to state exactly when the boiling commenced. Until recently, it was looked on as an advisable proceeding, but perhaps hardly worth the trouble, and was probably carried out somewhat perfunctorily. But, from the beginning of July, 1905, there can be very little doubt that, with the exceptions mentioned, all milk consumed by the troops in barracks has been definitely boiled, that is, "brought to the boil." Horrocks has shown that an exposure for 10 minutes to 68° C. (154° F.) is sufficient to destroy *Micrococcus melitensis*, naturally present in goat's milk (*i.e.*, the milk of a goat that is suffering from the fever and excreting the organism in its milk). Therefore, even supposing some laxity in the carrying out of the boiling regulations, the milk supply of the troops (with the exceptions noted) must be regarded as having been rendered harmless. So much attention was drawn to the question of the milk supply (consequent on the discovery of the presence in the milk of *Micrococcus melitensis*) during June, 1905, and the early part of July and the admissions for fever were so numerous throughout the garrison, that I feel no doubt that the boiling was carried out effectively, and not perfunctorily, from this time onward.

No diminution in the number of admissions occurred in August or September, when the full effect of this precaution would have become evident; on the contrary, the admissions increased from 67 in July to 86 in August, and in September numbered 77. The regiment that did not boil its milk (the Royal West Kent at Floriana) had an admission rate for the nine months of 43·53 per 1000, being the lowest but three of any corps in the island.

It may have been that men were infected by milk consumed outside barracks. This cannot be denied, but it is highly improbable. It is very rarely that the British soldier drinks milk at any time, and the refreshment of which he partakes during his hours of relaxation outside barracks is almost invariably of an entirely different description.

(2) *Conditions of Milk Supply among Married Families.*

A house-to-house visitation was made throughout the various married quarters, and particulars were obtained of the people's habits in this matter; the results of which are summarised in the following

paragraph. The figures refer to 1904 and 1905. I am aware that statements made in answer to questions of this kind have to be taken *cum grano*, but I feel confident that the actual state of things was ascertained in the great majority of cases, practically in nearly every case. Moreover, no instance has been put down as positive, *i.e.*, no use of condensed milk only, or of condensed and boiled milk only, has been returned as such, unless there was good reason to believe that this was really the case: any case of the least doubt has been returned under the heading of "unboiled, more or less."

Out of the 322 families thus inquired into, embracing a total population of 1213, it is seen that 441 persons consumed only condensed milk, and among these 14 cases of Mediterranean Fever occurred, giving a ratio of 31·74 per 1000. Amongst 398 persons, who drank either condensed or boiled milk, but never unboiled milk, 13 cases occurred, giving a ratio of 32·66 per 1000, which is practically identical with the first-mentioned. Taking these two categories together, we have a population of 839, with 27 cases, *i.e.*, a ratio of 32·18 per 1000. The remainder, 374 persons, who drank unboiled milk either habitually or occasionally, furnished 24 cases, *i.e.*, in an attack ratio of 64·17 per 1000, or exactly twice the incidence of the protected population. Taking all the men together, 10 cases occurred among 322, or 31·05 per 1000. All the women, 322, had 21 cases; all the children, 569, had 20 cases. The ratio for the whole population (51 cases among 1213 persons) is 42·04 per 1000. The women suffered the most, 65·21 per 1000; the men the least, 31·05 per 1000; the children very slightly more than the men, 35·14 per 1000.

If, for the sake of argument, we leave the men out of the question (for the importance of milk as a factor in causation is likely to be much less in their case than in the case of women or children), and deal only with the remaining population of 891, we find that 277 persons drinking unboiled milk furnished 21 cases (75·81 per 1000), while 614 persons drinking only boiled or condensed milk furnished 20 cases (32·57 per 1000).

If we consider the children only, as being those most likely to be affected, we find that 180 drinking unboiled milk furnished 13 cases (72·23 per 1000), while 389 drinking boiled or condensed milk furnished seven cases (17·99 per 1000), that is, the former suffered just four times as much as the latter.

The numbers are too small to prove anything, but there is, in my opinion, a considerable presumption that, in the cases occurring amongst women and children, the disease was introduced by infective goats' milk. It is to be noted that a disproportionate number of cases occurred in the Floriana married quarters (17 cases in 63 families, with a population of 230; three other women and one other man were attacked, but their milk supply is not known). As stated elsewhere

(Section II, § 8) there is reason to believe that some special cause was in operation in these quarters in 1904. Looking at the prevalence of the disease amongst the families as a whole, in spite of all the variations in the surroundings of the quarters, in their structure and sanitary fittings, the character of the milk supply appears to have an important, and in the case of children, a dominant influence.

(3) Particulars have been obtained in regard to 155 cases of Mediterranean Fever that have occurred amongst the troops in 1905, as to their consumption of milk before being taken ill. What the men usually say is, that they "drink no milk at all"; on further questioning this resolves itself into "no milk except in tea."

In 13 cases it was definitely acknowledged that unboiled milk had been drunk, in greater or less quantity, as a beverage; in nine cases that it had been taken in tea only. In these 22 cases infection by milk is a quite possible explanation of the causation of the disease.

In 26 cases it was definitely stated that no milk *at all* had been drunk, not even in tea; or if any had been taken in tea, that it was condensed milk; and in 17 cases it was stated with equal definiteness that, although milk had been taken in tea, it was known to be boiled. In these 43 cases infection by milk must be regarded as in the highest degree improbable.

Three men stated that they had consumed a considerable quantity of milk, but that it had always been boiled, or "sterilised." These three were cases that had arisen in Valletta Hospital, where an Aymard's steriliser has been in use for two years, and the statements may be taken as correct.

The remaining 87 cases stated that they drank no milk at all except in tea; whether or no it had been boiled they were not aware. It is the universal custom in barracks to add milk to the tea in the cook-house, before distribution; individuals, therefore, would not know whether it had been boiled or not. The practice of boiling the milk became general at the beginning of July, 1905:* any men admitted after the end of this month, if their milk consumption was confined to the regulation tea, are not likely to have drunk any milk other than what had been boiled. This applies to 34 cases. To these must be added seven cases in the Artillery (who use no goats' milk at all). Deducting (34 + 7 =) 41 from the 87 cases, there are left 46 cases, as to whom it may be said that infection by milk cannot be excluded.

It is seen that, out of the 155 cases, milk infection is quite possible in 22, and is not unlikely, or at any rate not to be excluded, in

* The West Kent Regiment did not boil their milk until later; only three of these cases belong to this regiment, and they were admitted before June; the *omission* of the precaution did not apparently bring about any cases in this regiment during July and later, any more than its *adoption* prevented their occurrence in the other regiments.

46: while it is unlikely in 41, and in the highest degree improbable in $(43 + 3 =)$ 46. I regret that I have been unable to interview every one of the 487 cases that have occurred during the period under review. All the cases that I was able to get access to I did examine, with the result just stated. I have no reason to doubt that they present a fair sample of the whole; but the account is, of course, not a complete one, referring only to about one-third of the cases that occurred. If trustworthy information could be obtained as to 500 cases, the question might be settled. As it is, I consider that while the evidence as regards married families, and especially children, is fairly strong in favour of the transmission by milk, as regards the troops it is negative. It would not be justifiable to affirm that the circumstances of the milk supply of the troops, considered in relation to the fever prevalence, in any way invalidate the theory of milk-transmission; but I do not find anything in these circumstances, as they existed during 1905, to lead one to suppose that milk can have had any important part, or indeed any part at all, in disseminating the specific poison during this epidemic *amongst the troops.* The experimental evidence obtained by the laboratory investigations of the Commission during the past year have been so conclusive as to the infectivity of goats' milk in Malta, that no want of proof from the epidemiological side can weaken its force; all that can be said is that milk does not explain the incidence of the disease upon the troops during this particular period. That a body of men such as the Royal Artillery, numbering about 2000, should have had 88 cases (45 per 1000), although practically they drink no goats' milk at all; that of these men some companies (such as those at Upper St. Elmo) should have had an attack rate as high as 66 per 1000; while the general attack rate has been 53, in one regiment only 27, and in a regiment that habitually partook of unboiled milk not more than 45 per 1000 (exactly the same as in the Artillery who drank none at all)—this indicates that milk infection has not been an important mode of propagation among the troops.

A rational explanation of this lies in the fact that, as already mentioned, milk enters but very slightly indeed into the dietary of the British soldier. Occasionally and exceptionally the reverse is the case; and it is not at all unlikely that the men who have been in the habit of drinking milk (as a beverage or food, not merely in tea, etc.), have suffered largely. There are, however, no statistical data in existence as to the frequency or rarity of milk-drinking amongst soldiers. It is impossible, therefore, to say whether or no these milk-drinkers have suffered disproportionately in Malta.

§ 5.

iii. *Infected Air.*—Recent researches have shown (1) that *Micrococcus melitensis* is discharged in the urine of Mediterranean Fever patients, being frequently present in enormous numbers; (2) that it is able to survive in a dry state for long periods when not exposed to the direct rays of the sun; (3) though it has not been demonstrated in the fæces of patients, Eyre has found it in the fæces of artificially infected guinea-pigs. There is, therefore, good ground for supposing that air containing excretally contaminated dust may bring about transmission of the disease. Such air may be "sewer air," or "latrine air," or "urinal air," or (in Malta) the air of houses, streets, roads, and fields throughout the islands.

(*a*) The well known observations of Carnelley and Haldane, Parry Laws and Andrewes, Petri, and others, have shown that the air of sewers, which are regularly and properly flushed and ventilated, is remarkably free from micro-organisms of any kind; moreover, those that are present are derived from the external air rather than from the contents of the sewer. When fermentative or putrefactive processes occur, however, with formation of gas bubbles, there is a likelihood, as Frankland has pointed out, that sewage microbes may be disseminated in the air. Tichborne considered that they might be carried about, as on a raft, by condensed vapour formed during the cold hours of the night, and dissipated when the air becomes warmed, leaving the imponderable microbe floating in the air. There is such a large body of evidence connecting outbreaks of infectious disease with the breathing of air contaminated with sewer emanations that some such explanation is required; notwithstanding the observed paucity of micro-organisms (and *a fortiori* of pathogenic organisms) in the extensive experiments that have been carried out, the connexion between disease outbreaks and the breathing of sewer air, or excretally contaminated air, has also been a matter of such frequent observation that the possibility of transmission of disease in this way cannot be disregarded. It is known that bacteria cannot be given off from a surface that is kept constantly moist; from a surface that is alternately moist and dry, however, they would be likely to be dislodged by various causes, such as concussion, strong currents of air, or even in the course of drying. The sewerage system of Malta has up to the present suffered from a very insufficient supply of flushing water; and there is no doubt that, to a very great extent, the sewer walls have been alternately wetted and dried, and therefore in a condition to render the disengagement of sewage organisms, including the various pathogenic bacteria present in the excreta of infected persons, not only possible but likely. Amongst these pathogenic bacteria *Micrococcus melitensis* must be considered to be potentially present for a great part of the year.

In regard to barracks this inadequacy of drain flushing has also existed to a greater or less extent. At Upper and Lower St. Elmo, Floriana, St. Francis, Manoel, Tigne, and Ricasoli the amount of flushing water has been on the whole sufficient, and the condition of the drains satisfactory; that is to say, they have been self-cleansing, and their walls have been free from deposit. At St. James' Cavalier, Verdala, throughout the Cottonera Lines, and at St. George's, Pembroke, the flushing water has been, as a general rule, throughout the first nine months of 1905, scanty; it is probably correct to say that it has been insufficient for the proper cleansing of the drains. At Imtarfa it has been somewhat scanty, and at Gozo. St. Andrew's has only been taken into occupation during the summer of 1905; so far there has been a sufficient supply of flushing water. There has been no scarcity of flushing water for the drains at any of the hospitals. Throughout all these barracks the drainage systems are, on the whole, of modern type, well laid, well ventilated, and well trapped; only once did I find any serious obstruction. There are however numerous defects of detail in construction or maintenance which require attention (as specified in a separate report), and which, unless attended to, will in course of time lead to dangerous conditions in the barrack drainage systems. As especially bearing on the point now under consideration—escape of sewer air—may be mentioned the following:—(1) The unsealing of w.c. traps in several married quarters in Strada Magazzini, Floriana (owing to the quarters being vacant and the closets disused). (2) The unsealing of gulley traps outside Married Quarters at Imtarfa, owing to no water being used for washing the verandahs (to receive which these traps were provided), and to long-continued dry weather. (3) Direct communication with a drain at the side of the road within a few yards of the back gateway of Verdala Barracks, an inlet acting as an outlet, and the drain being imperfectly ventilated, so that a bad drain smell is perceptible on a much-frequented roadway. (4) There has been persistent complaint on the part of the occupants of the Old Block of Married Quarters in St. Francis Ravelin, as to bad smells coming from the ventilating shafts of the Civil Government sewer, the nearest of which shafts is some 300 or 400 yards distant; alterations have been made from time to time, some shafts have been closed, and one has been carried to a greater height; the nuisance, however, still continues. (5) At Couvre Porte there is a ventilating shaft for the Civil Government sewer, opening over the roof of the barrack, and 42 feet above it; bad smells are complained of, especially at night.

The above five instances of escape of sewer air into, or in the neighbourhood of, barracks and quarters are the only definite cases that came under my notice in making my enquiries as to the sanitary condition of barracks in Malta. In the first instance, at the Strada Magazzini Married Quarters, Floriana, at the time of my visit a stoppage had

occurred in the main drain of the block of quarters; I was informed that this was not an uncommon occurrence: as two branch drains at least enter the main drain at right angles, instead of in the direction of the flow, a stoppage is not unlikely to occur from time to time; but I understand that on this occasion the actual obstruction was lower down, near to, or at, the junction with the street sewer. Such inspection pits as are provided are cemented down, so that the condition of the drain cannot be seen to and precautions taken to prevent a stoppage; consequently it may exist for a day or two, or more, before being discovered; meanwhile the foul air is laid on to the quarters, in which are situated the untrapped W.C.'s, and from them escapes into the small backyard, whence it gains access to the quarters above, whose windows open into this yard. Bad smells were particularly complained of by the occupants of No. 12 (Barrack Warden Budden) and No. 13 (Corporal Bellfield, Royal West Kent Regiment). Mr. Budden had an attack of Mediterranean Fever in June, 1905, his two children suffer from sore throat, not severely, but chronically. Corporal Bellfield's family have not suffered from any fever or throat affection. The wife of Corporal West (Royal West Kent Regiment), who occupied No. 6 quarter (in which is one of the faulty W.C.'s) the year before, was admitted for Mediterranean Fever in June, 1904. The occurrence of these two cases of the disease in connexion with the faulty sanitary condition is to be noted; but no other cases have occurred in these quarters, nor have I been able to trace any connexion between the occurrence of Mediterranean Fever and the other instances of sewer air nuisance just mentioned. It is true that six cases have occurred during 1903–5 in the Old Block of Married Quarters, St. Francis Ravelin, which have been thought to be due to effluvia escaping from the civil sewer ventilator, some 300 or 400 yards distant. This, however, does not appear to be probable. Two cases were admitted from Couvre Porte in 1904, and one in 1905. This does not indicate any particular infective property in the emanations from the sewer ventilator above the roof of this barrack, undesirable as they undoubtedly are. Several cases of illness—often fatal—occurred during the summer amongst the children occupying the Married Quarters at Imtarfa, where drain air escaped through unsealed traps on to the verandah; but none of these were Mediterranean Fever.

The theory of infection by sewer air of course presupposes that there has been previous passage of the specific *contagium* into the sewer in question. There is little difficulty in believing that this is the case in regard to the public sewers of Valletta, etc.; but in the specific instances mentioned of drain emanations in barracks the same cannot be said; there were but few cases of the disease at Verdala and Imtarfa, therefore little active contagion passing into the drains; and it would be making too large an assumption altogether to put down these cases to

drain infection. In fact, the barracks where the flushing of the drains was most inadequate, such as Verdala, Cottonera Lines, and St. George's (in which therefore the drain air would be most dangerous) have not suffered the most severely; while the barracks that have suffered most (Upper and Lower St. Elmo, Tigne, and the two large hospitals) are those which, whatever their other sanitary shortcomings, have at any rate had no lack of water for flushing, no troubles with regard to their drainage arrangements, and certainly no defects leading to sewer emanations in the barracks.

The effect of breathing emanations from the public sewers in Valletta, etc., would be more likely to be evident in those who live in the crowded parts of this city, or of the other thickly populated places across the Grand Harbour. A plausible explanation would be thereby afforded of the high incidence on Upper and Lower St. Elmo, neither of which barracks can be approached without passing along crowded streets, whose inhabitants (mostly, though not all, of the poorer class) have little regard for any kind of sanitation, and are content that their closets and drains should be habitually foul and pestiferous. Verdala is however in almost equally bad case in this respect, yet it has suffered very slightly.

(*b*) *Latrine Air.*—The condition of the latrines in the different barracks in Malta is, in many cases, extremely unsatisfactory, the cause generally being an inadequate water supply. The type of latrine in general use is the "Jennings' continuous pipe latrine," which is a good pattern and, when properly used, quite free from offence. The dry earth system is still in use in some barracks. At Lower St. Elmo new water-closets were fitted up in the early part of 1905, with improved siphonic flushing arrangements; although these arrangements are susceptible of further improvement the latrines, both upstairs and downstairs, have been kept in a sanitary condition without difficulty, and the water supply has been ample throughout the year.

At St. Andrew's Barracks, only recently completed, the latrines are new, and of good pattern, and the water supply has been so far ample. At Fort Ricasoli, and at Valletta, Cottonera, Forrest, Imtarfa, Citta Vecchia and Gozo hospitals, the water supply has been sufficient, and the latrines kept in good order.

Throughout the rest of the barracks the latrines have not, speaking generally, been kept in a satisfactory condition. In the various barracks that make up the Cottonera Lines the supply of water for flushing has habitually been inadequate; indeed, it has often been altogether cut off, so that the latrine pans have been allowed to become partially dry, excreta remaining in the pans and fouling the sides, and in this way gradually drying up and becoming scattered about as dust; this occurred at Polverista, St. Paul's Bastion,

Vittoriosa, and elsewhere. At Upper St. Elmo, St. James' Cavalier, Floriana Old Barracks, and Verdala, the water supply has been scanty, and the flushing not done often enough; consequently, the latrines have habitually, or frequently, been over-full; in which case, when they are emptied, there is a likelihood of excreta remaining on the sides of the latrine to a greater or less extent, and eventually becoming dried and disseminated as dust. At Tigne a new latrine has quite recently been opened; at present it is in good order and quite clean. Tigne (until July, 1905), Manoel, Pembroke Fort, Imtarfa, Gozo, and all the outlying forts and encampments (except Fort Rinella and Camp Mellieha) have had the dry-earth system of removal; the removal is effected once only in the 24 hours, very early in the morning, about 3.0 or 4.0 A.M. As the greatest use of the latrines takes place between 8.0 and 10.0 A.M., it follows that the excreta are retained in the lines for from 16 to 18 hours every day instead of being removed at the earliest possible moment. If the application of the dry earth were immediate and thorough, this retention of foul matter might perhaps be harmless, or even inoffensive. As a matter of fact, it is very seldom the case that the system is properly carried out, and the net result is that dry-earth latrines are generally in a filthy and insanitary condition, for, at any rate, many hours of the day and night. All the latrines on this system in Malta (with very few exceptions) have been habitually in a foul state. Fort Rinella and Camp Mellieha have a water system of removal, with a good supply of water. Fort Ta Silch has had a dry-earth latrine for night use (which has also been habitually used during the day), and a temporary trench system just outside the fort; this arrangement has been very unsatisfactory.

The only barracks that can be considered to have been free from the effluvia of fæcal matter are those first mentioned, viz., Lower St. Elmo, Ricasoli, and St. Andrew's; also Fort Rinella and Camp Mellieha; in all the others persons using the latrines have, during a great part of the day, been subject to whatever risks may be considered to arise from breathing air contaminated with fæcal emanations, that is, effluvia from excreta in a more or less fresh condition. All the hospitals have been free from this risk. The case, as regards Mediterranean Fever in these barracks, is that the occupants of Lower St. Elmo have suffered more than those of any other barrack, and the occupants of St. Andrew's to about an equal extent with those of most of the barracks (see Table I); Ricasoli has suffered but slightly. The hospital population has suffered considerably, but this can hardly have been on account of the state of the latrines, which have been maintained in a satisfactory condition throughout the island.

In the two barracks that have suffered least, although in Ricasoli the latrine air has been free from fæcal emanations, in Verdala the reverse has been the case: while of two barracks, lying alongside of

each other, and similar in situation and general construction, St. Andrew's, with quite new latrines well flushed, has suffered more than St. George's, with scantily-flushed latrines, many of which have been in existence for a long time, and have therefore become proportionately foul.

There does not appear, therefore, to be any definite evidence connecting the incidence of Mediterranean Fever with the presence of fæcal emanations, as far as concerns the troops, during the period under review.

As regards married families, the principal Married Quarters—Camerata, Tigne, Old and New Floriana, New Verdala, St. Nicholas, Ricasoli, and St. Andrew's—are provided with water-closets of excellent pattern, and are quite free from any kind of drain or latrine emanations. This cannot be said of the older quarters, such as St. Nicholas Back, and the old St. George's blocks, where latrines of old pattern are still in use; nor of the hired quarters in Strada Magazzini, Floriana, which have been already alluded to. Although a few cases have occurred in the latter quarters, most of the women and children attacked have lived in the newer quarters (such as New Floriana), which are provided with water-closet chambers and fittings of the best and most modern kind. Such cases cannot be regarded as due to infection through "fæcal emanations."

(*c*) *Urinal Air.*—The recent researches as to the viability of *Micrococcus melitensis* in dust, and the demonstration that Mediterranean Fever can be communicated to goats (though not, so far, to monkeys) by feeding them on dust infected with the urine of Mediterranean Fever patients, make it necessary to examine into the condition of barracks in regard to the presence or absence of urinary contamination of the air. Throughout the island the barrack urinals are constructed on the same general plan, viz., ranges of partitioned stalls made of slate, flushed with water from a sparge pipe, the flow being carried direct into the nearest drain. It has been for some years the custom to cover the slate surface with tar from time to time, a result of which has been that the surfaces have generally become rough and uneven, leading to collections of urinary sediment all over the lower part. The water flushing has also been quite inadequate to keep the stalls clean; this has been partly due to an insufficient quantity of water being used, and partly to its being inefficiently applied, the holes of the sparge pipes being very generally blocked up, or the pipes themselves being fixed in a wrong position. The consequence has been that barrack urinals have generally been dirty and ill-smelling. During the past year a new arrangement has been brought into use, according to which the water flushing is omitted, and in its place the urinal surface is coated over with a mixture of kerosine oil and lamp-black or tar. The best application for the purpose is a substance

called "heavy oil," but, as this has apparently not been procurable in Malta, various substitutes have been used in its stead: a mixture of colza oil and tar in equal parts, as used at Imtarfa, appeared to me to be the most effectual, and needed only to be applied once a week. No deposit takes place on the back of the stall, and there is not the least offensive smell. Elsewhere, results have not been so satisfactory. But when this, or some similar application, is used effectively, the urinals are undoubtedly cleaner than under the old arrangements. Although water must not be distributed over the surfaces to which the oil or tar has been applied, it is necessary to flush the *drain* with water, and to wash down the floor of the urinal frequently, otherwise the floor and the drain will become foul. This is what has occurred in practically every urinal in every barrack throughout the island; urine has been allowed to dry on the floor, and so become converted into dust and pollute the air.

With the knowledge that we now have that Mediterranean Fever often occurs in an ambulant and unrecognised form, there is little doubt that infective urine has been widely distributed throughout barracks in this way. On the other hand, it has been shown that exposure to direct sunlight destroys the specific organism in a few hours (Horrocks). In some barracks, as in Upper and Lower St. Elmo, the old barracks and bastions in Cottonera Lines, Verdala, St. Francis, Marsamuscetto, Old Laboratory, the old part of Floriana, and in the detached Forts, the urinals are under cover and shielded from the direct rays of the sun. This is also the case in all the hospitals. Under such circumstances *Micrococcus melitensis* might live for several days, as Horrocks has found that it will survive for 28 days in ordinary street dust, and in "building dust." In the newer barracks, such as Tigne, New Floriana, St. George's, St. Andrew's, and Imtarfa; also at Manoel, Ricasoli, Gozo, and, of course, in all the camps, the urinals are out in the open, without covering of any kind. The duration of infectivity of the dried urine would appear in these places to be very short indeed, almost negligible. It is certainly the case that the places which have suffered most, viz., Valletta and Cottonera Hospitals, Lower and Upper St. Elmo Barracks, have urinals that would retain infectivity longer than such barracks as Ricasoli, St. George's, and Imtarfa, that have suffered comparatively slightly. Also, Floriana *New* Barracks have had fewer cases proportionately than the *Old* buildings. But in the case of the two hospitals named much more care has been taken than in barracks generally to keep the floors of urinals clean, and in these places I do not think any appreciable risk of infection can have been incurred in this way. St. George's and St. Andrew's are identical in this particular respect, but have suffered differently; and Verdala, which has fared better than any other barrack but Ricasoli, has urinals as dark, and almost as confined,

as in any barrack. While there can be no doubt that every care ought to be taken to prevent fouling of the ground with urine, and to cleanse it frequently, when fouled, it can hardly be said that the fouling which has occurred affords any satisfactory explanation of the distribution of the disease during the recent epidemic.

There is another way, however, in which urinary infection may have been spread. None of the barracks in Malta are provided with night urinals. In every case the urine tub is still in use. In the older barracks it is placed on the floor outside the barrack-room door in the verandah or passage. In the newer barracks a special stand is provided. At Tigne New Barracks, St. Andrew's, and the new blocks at St. George's, the tubs are placed in an alcove behind the barrack-room, and, on the upper floor, have to be brought *through* the room, in order to be taken downstairs to be emptied.* It must often happen that urine gets splashed about on the floors. It is conceivable that infection might be spread in this way, and that the admission rate from these new, and in most respects sanitary, barracks has been raised from this cause.

Although *Micrococcus melitensis* can survive in dried dust for about a month, and it has been found possible to infect goats by feeding them on such infected dust, experimental infection by inhalation has not been fully demonstrated in regard to monkeys. In Part I of these Reports (pp. 46, 72) Horrocks detailed two experiments which indicated that "*Micrococcus melitensis*, when present in dry dust, is capable of being absorbed by monkeys"; but in the account of further experiments in Part IV (pp. 29, 31) the same observer stated that it had "not been found possible to infect monkeys with dust polluted with urine from Mediterranean Fever patients and then thoroughly dried. Goats, however, can be infected in this manner." As the enormous doses of strongly infected dust employed in these experiments are only occasionally capable of transmitting the disease, the probability of there being any habitual pathogenic property in the dust of urinals or rooms contaminated in the manner just mentioned, appears to be very remote. The possibility, however, cannot be disregarded; and although the *quantity* of the contagium may have been minute at any one point of time, it is likely that it has been constantly present in such places as Lower St. Elmo.

(*d*) The habits of the bulk of the Maltese population, as in Southern Europe generally, bring about a fouling of the ground with fæcal and urinary excreta. The offices of nature are performed not only in private, but in public, places, advantage being taken of every nook and corner that offers. Around the barracks that are situated in the old fortifications there are so many ditches and secluded spots that the

* It is probable that the same thing happens, though it is not necessary, on the lower floor, in order to save trouble.

whole neighbourhood is sometimes a latrine; even within barrack limits it is often impossible to prevent this fouling of the ground by the native population. Floriana Barracks (including Notre Dame Ravelin and the intermediate ground) and Verdala, also all the Cottonera Lines, are instances in point. Outside Lower St. Elmo on the shore of the harbour, and in the Jews' Sallyport, the condition of the ground is particularly filthy. Wherever building operations are being carried on, as has been the case between the Porta Reale and Floriana Barracks during the past year, the fouling of the ground is also extreme. On one morning I counted 13 separate *dejecta* immediately outside the northern end of Floriana Barracks. It may be said that wherever troops are quartered in or near native towns or villages this fouling occurs in the immediate vicinity of their dwellings. Where they are removed from this undesirable propinquity it does not exist; as, for instance, at Manoel, Tigne, Ricasoli, Imtarfa, Gozo. The civil authorities seem powerless to put a stop to this nuisance; and of course the military have no control over ground outside barracks.* However, insanitary and disgusting as this condition is, it is not easy to prove any bad effects resulting from it in regard to Malta Fever, in view of the strong disinfectant action of sunlight that has been already mentioned. Only in such places (like the Jews' Sallyport) that are covered in, would the specific micro-organism retain its vitality for any considerable length of time. So also in the streets generally, though many corners are fouled, it may be assumed that the virulence of *Micrococcus melitensis* is soon destroyed by exposure to the sun. In the fields human excrement is frequently used as manure. Horrocks has found that *Micrococcus melitensis* may survive for 20 days in manured garden soil in the laboratory; but in the open fields, fully exposed to the sun, this would only be possible at some distance below the surface, from which situation it would not be likely to be dispersed about in the air, and inhaled or swallowed by any passer by.

The air of the streets of Valletta and other Maltese towns is, however, polluted from another source, viz., from the underground cellars, or basements, often used as dwellings, and in which there are often water-closets of the most defective kind. These closets are very scantily flushed with water, which has to be fetched by hand for the purpose, and, supposing any inmate of the basement dwelling is suffering from Mediterranean Fever, must undoubtedly be a source of danger to the other occupants; and not only to the occupants, but to the passers-by in the streets above. The effluvia that rise from these basements are often very offensive, and obviously excrementitious: as

* There is, I believe, one exception to this. I was informed that the troops occupying Lower St. Elmo are charged with the duty of keeping clean the Jews' Sallyport, which is used as a latrine by the natives of the neighbourhood.

these places are dark, and never penetrated by the sun's rays, there is no reason to suppose that *Micrococcus melitensis* would lose its virulence in a hurry in such a situation. Alternations of temperature cause currents, upwards and downwards, from these basements; and it is within everyone's experience that the current upwards is sometimes (like the effluvium) of considerable strength, and quite able to carry up micro-organisms from the closet below to the street above. In this way the men occupying barracks such as Upper and Lower St. Elmo, which cannot be approached except by passing along streets having basement dwellings of this kind, are more liable to aërial infection than the occupants of barracks such as those at Pembroke and Imtarfa, situated away from such streets and dwellings.

(*e*) In the late Captain Hughes's treatise on Malta Fever there is a strong body of evidence in regard to the association of fever outbreaks with "insanitation"; implying by this contamination of the air of the barrack or dwelling with emanations from drains, cesspits, etc., or putrefying organic matter, or polluted soil. Fifteen separate outbreaks of greater or less extent are carefully described in which the connexion certainly appears to be one of cause and effect. I made particular enquiry of 187 patients suffering from the disease, as to whether they had been conscious of any insanitary condition, or "bad smell," in or near their quarters, which might seem to be connected with their illness. The information gained was disappointingly meagre. In only six cases was there any idea, from the patients' side, of any connexion between "bad smells" and their illness. In one case a W.C. in the officers' mess, where the man was employed, had been frequently stopped up and offensive. In two cases the regimental latrines sometimes became choked, and the men had to clear them, which was a disagreeable job. A man employed at the officers' mess in the Inquisitor's Palace, slept on the ground floor, where there were often bad drain smells.* One man (and one only) complained of the bad state of the latrines in Cottonera Lines. One serjeant complained of a bad smell in his "bunk," which was very imperfectly ventilated (Lower St. Elmo). This testimony is of very slight importance one way or the other; all one can say is that there does not appear to have been any notable or widespread offensiveness in any of the barracks sufficient to excite attention. This is, after all, what one would expect *in barracks*, where the dwelling rooms are quite disconnected from the latrines and drainage. Only in the old fortress barracks, and in hospitals, are these conditions reversed. But during the last 10 years very great improvements have been made in the condition of these old barracks, and the insanitary conditions detailed by Hughes are not, to the best of my belief, now existing in any quarters occupied by troops

* This quarter (and the mess building) was evacuated shortly afterwards. When I examined it, I could find no defect in the drainage arrangements.

in Malta. The evidence collected by him is, in my opinion, strongly in favour of a causal connexion between Mediterranean Fever outbreaks, and the laying on of excrementally polluted air to dwelling rooms; but I have not been able to gather any similar evidence that would in any way explain the incidence of the disease during the past year amongst the troops.

§ 6.

Having reviewed the influence of water, food and air as channels of infection in Mediterranean Fever, with on the whole a negative result, that is, without having succeeded in tracing any definite relationship between its mode of prevalence amongst the troops and the existence of conditions pointing to probable infectivity of these media, we are now led to the consideration of what appear to be the only other alternatives, viz., direct or semi-direct contagion, and the agency of some biting insect.

As to direct contagion, Hughes, writing in 1897, dismisses the question very shortly. "Patients suffering from other diseases, occupying beds next to cases of undulant fever, do not develop this fever, nor do the military sick attendants in fever wards suffer more from this fever than those working in other wards, or so much as soldiers in many of the barracks in Malta who have not entered the hospital previous to the onset of their attacks."

The following table is extracted from a paper by Capt. J. C. Kennedy,* and shows the prevalence of Malta Fever amongst patients and orderlies at Valletta Hospital, as compared with the garrison in Valletta, for the years 1897—1904. The figures are ratios per 1000.

	Valletta Garrison.	Valletta Hospital patients.†	Valletta Hospital orderlies.
1897	42·11	11·05	80·00
1898	22·78	29·99	163·63
1899	22·54	32·00	34·48
1900	26·68	6·44	54·05
1901	43·11	45·75	121·21
1902	16·90	34·18	48·78
1903	67·31	24·53	50·00
1904	45·42	14·43	169·23
Average ...	36·23	24·79	92·4

* 'Journal R.A.M.C.,' May, 1905.

† Cases that have been diagnosed as Malta Fever within 20 days after admission, and cases that have been changed from S. C. Fever to Malta Fever after admission, have been excluded. Also cases that have been admitted from outside, but which may have contracted the disease inside, hospital are not included.

Captain Kennedy points out that venereal patients, and patients suffering from injuries, were much more liable to contract the disease than others, the ratio being 3·31 per 1000 venereal admissions, 2·42 per 1000 admissions for injury, and only 0·76 per 1000 admissions for all other diseases. He explains this by the facts that these patients spend a longer time in hospital, on the average, than any others (except Malta Fever); and that they are all treated in one ward, 20B, which is in communication with, indeed is part of the same room as, other wards containing Malta Fever patients. In 1905, 11 cases have apparently been contracted in Valletta Hospital, of which 8 were staying in 20B Ward and 2 in 20A Ward; the ward in which the remaining case stayed is doubtful. At Cottonera 10 cases apparently contracted the infection, of which 3 were inmates of wards in which the fever cases were treated. As regards orderlies, Kennedy states that of the 11 who contracted the disease at Valletta in 1904, 8 were doing duty in 20A, 20C, and 37 wards containing Malta Fever patients. In 1905, of the 19 at Valletta who were attacked, 11 were employed in the fever wards. At Cottonera 5 out of 7 cases amongst orderlies were similarly employed; as were the two cases of R.A.M.C. at Citta Vecchia.

Now, leaving on one side for a moment the case of the orderlies, who are exposed to various possible sources of infection, what is the most probable explanation of the occurrence of these cases of infection in patients who are confined to the hospital precincts, and in some instances to their beds? At both Valletta and Cottonera Hospitals the drinking water is above suspicion, the milk has been "pasteurised" since the middle of 1904, and the wards are absolutely free from any kind of contamination from sewer air, or latrine air, or urinal air. Whatever the sanitary shortcomings of the "Long Ward" in Valletta Hospital may be, it is certainly not exposed to any danger of this kind; neither are the other wards in this hospital, nor any of those at Cottonera. Of course, patients who are able to get up make use of the latrines and urinals of the hospital; but in neither of these hospitals has there been any failure in the water supply to latrines, leading to insufficient flushing, nor has there been any reason, even the slightest, to suspect that drain effluvia gain access to the latrine or closet chamber. The latrine for 20B Ward is certainly old and defective, and a considerable waste of water results on account of the defective fittings; also the latrine and urinal for No. 37 has a rough floor, which requires concreting. But though these conditions are insanitary and undesirable, they cannot be reasonably held to be causative of Mediterranean Fever.

The condition that appears to be the most probably effective in the causation of these hospital cases is the presence in the wards of a large quantity of disease-producing material in the bodies of the patients

themselves. It is known that the specific organism is present in the blood, and is excreted in the urine; it is possibly excreted in fæces, but up to the present has not been demonstrated in the breath, saliva, or perspiration. Transmission by direct contagion is therefore not theoretically probable; by indirect or semi-direct contagion through clothing soiled with excretal discharges it is not improbable in the nature of the case, although hitherto there has been no proof of this mode of spread. The position, however, is not unlike that of enteric fever, which is now considered (in fact, may be said to have been proved) to be spread by means of "contact," *i.e.*, close association. Presumably this happens by infective urine or fæcal matter fouling the skin or clothing of the patient, and then becoming disseminated through the air, and inhaled; or finding its way into articles of food or drink, and being swallowed. We have the authority of Koch for the opinion that transmission of enteric in this way is its most important mode of propagation. A few years ago this would have been considered most unlikely, but proofs have been accumulating. I do not see that there is any essential difference between the position as regards enteric fever transmission and Mediterranean Fever transmission. Where there is a large quantity of the infective material accumulated in one place, *i.e.*, in a hospital, there the likelihood of its spread is the greater. That this spread occurs but very seldom is because the obvious precautions usually taken are sufficient; but when the number of cases (*i.e.*, quantity of specific poison present) is largely increased, it may probably happen that the precautions are not increased *pari passu*, because the labour involved increases out of all proportion to the working power present. A patient severely ill may pass involuntary evacuations twice or three times in the night. There may be (and have been) two or more such cases in the same ward; obviously the risk of dissemination of infective particles becomes much increased when this occurs. Even with the best methods of disinfection in every detail, of the person, of the clothes, of the evacuations, there must be a chance under such conditions of infective material being spread about. This seems to be a mode of propagation that cannot be excluded; it is applicable to the other occupants of the wards, and especially applicable to the actual attendants on the fever cases.

With regard to the behaviour of the epidemic among the troops in barracks, from the preceding part of this section it appears that neither water, nor food, nor air contaminated with drain emanations will explain the incidence of the disease; the one fact that stands out most clearly is that the fever has occurred in a number of small outbreaks, almost strictly localised in some place, or limited to some small body of men. Examples of this have been instanced in the case of G and H Companies, Essex Regiment, at Lower St. Elmo; A Company, Royal Dublin Fusiliers, at St. George's; the men of the Royal West Kent

Regiment that occupied the Old Barracks, Floriana. In each of these instances, where several cases of fever occurred in the same room, or same set of rooms, there was an appreciably larger quantity of infective material in those rooms, than in the barracks generally; the more there was of it present, the more likelihood would there be of the infection spreading.

There is one condition, common to Lower St. Elmo and Floriana Old Barracks, that would presumably be of importance in aiding this spread of infection. The rooms are casemates, most inadequately ventilated. If it be granted that the infective material is disengaged from the bodies of persons suffering from the disease, no better place could be found for its accumulation from day to day and night after night than a casemate such as those in question. It is extremely improbable that a thorough change of air ever takes place in these cavernous chambers. It is quite impossible that any thorough change should be effected frequently. The construction of the rooms and their size prevent it. I do not think it too much to say that the Long Ward in Valletta Hospital is in similar case as regards change of air. Though very large and lofty, the thorough change of the contained air is very difficult to effect: and as the upper windows have not (to the best of my belief) been fully utilised as outlets, I consider that there has been an accumulation of infective material in the air of this ward from day to day and night after night.

In regard to the barrack-rooms at St. George's that were so much affected (A Company, Royal Dublin Fusiliers), nothing can be said against their ventilation. But the bedcots are crowded together, so that only about 12 inches separate each pair of beds, and there has therefore been concentration of the persons, and consequently of the infective material. It may be asked in this, as in the other cases, where many barrack rooms are similarly circumstanced, why some should be affected and not others. The reply would be that it is necessary that the poison should be introduced, and probably introduced in some notable quantity; having once been introduced, the conditions mentioned would naturally favour its spread.

There are two main difficulties to be met in adopting this theory, or explanation, of the prevalence. One arises from the fact that *Micrococcus melitensis*, though often sought for, has not been found either in the air of the Valletta Ward or in the dust collected from it, and from the Cottonera Wards. The other is that it has not been found possible, so far, to infect monkeys with urine-infected dust. It must be admitted that these are substantial difficulties in the way of this explanation.

§ 7.

In regard to the question of transmission by fomites, the experiments of Horrocks, who found that *Micrococcus melitensis* could be

recovered from khaki cotton, khaki serge, and blankets up to the 80th day; and of Shaw, who recovered it from blue serge up to the 78th day, show that this form of dissemination has practical importance. The necessity for disinfection of clothing, etc., is fairly obvious. The procedure that has been carried out has varied in the different corps stationed in Malta, as appears from the following statements obtained from the regimental authorities :—

Royal Garrison Artillery (Upper St. Elmo), 65th Company.—In the earlier part of the year the kit and bedding of men admitted to hospital were placed in the company store until instructions were received from the medical authorities that they should be sent to hospital for disinfection. Since the middle of August, in the case of all men admitted with "fever," the kit and bedding have been put on one side in the "Old Magazine," awaiting instructions as to their disposal.

96th Company. It has always been the custom to put on one side the kit and bedding of all men admitted to hospital. When the case was declared to be "fever," the whole kit and bedding has been sent to Cottonera Hospital for disinfection.

Tigne, 99th Company. The kit and bedding of all men admitted to hospital have been placed in company store; on receipt of instructions from the medical officer in charge of the district, either "kit," or "kit and bedding," have been sent to the lazaretto for disinfection.

1st Company. Same as in 99th Company. In about half the cases, "bedding" only has been specified, and the "kit" has not been disinfected.

102nd Company. The kit and bedding of all men admitted to hospital are placed in company store. In infectious cases a paper of questions is sent by the medical officer to the commanding officer; one of these has reference to the kit and bedding; if they have not been disinfected they are to be sent to the lazaretto for disinfection. It may be 10 days after a man has been admitted to hospital that instructions arrive as to disposal of kit.

Ricasoli, 5th Company. When a man goes to hospital, his kit and bedding are taken into the company store; if instructions come from the hospital authorities his "kit" is sent to Cottonera for disinfection, but *not* the "bedding."

63rd Company. Same as in 5th Company, except that the "bedding" is sent to be disinfected but *not* the "kit."

100th Company. Same as in 5th Company: the bedding is *not* disinfected.

Hampshire Regiment (Verdala).—When a man reports sick, his kit and bedding are brought out of the barrack room and placed in the company store. If he is not admitted to hospital, he takes his kit and bedding back to the barrack room. If he is admitted, his kit and bedding are stored in the company store, the blankets being all stacked together in order, the sheets all together, and the mattresses all together. There is no certainty that a man receives the same blanket on discharge from hospital as he handed in when admitted. Sheets and pillow slips are washed. No difference is made between "fever" cases and others. Any dirty clothing in the kit bag remains *in situ*. In infectious cases, instructions come from the hospital authorities to the commanding officer that "kit and bedding" are to be sent to hospital for disinfection on some named date. Some days, a week or more, may elapse (after the man's admission) before these instructions are received.

Lancashire Fusiliers (Lower St. Elmo).—The kit and bedding of men admitted to hospital are stored in the company stores (the prison cells being used for this purpose). The hospital authorities notify (after an interval of some days) when the kit and bedding are to be sent for disinfection. There are no means of keeping

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separate the kit and bedding of "suspected," *i.e.*, fever cases: but if any man is admitted with "fever" his kit and bedding are sent for disinfection on the first Tuesday or Friday that follows.

Essex Regiment (Imtarfa).—The bedding and blankets of men admitted to hospital are sent for disinfection when so ordered by the hospital authorities, but the kit remains in the man's kit bag, unless obviously dirty, in which case it is sent to the wash. Kits and bedding are stored in parts of barrack rooms appropriated for the purpose, there being no space for their disposal in the rooms labelled "company store," which are little better than cupboards.

Royal West Kent Regiment (Floriana).—Formerly the bedding of men admitted to hospital used to be left in the barrack room. Early in the summer of 1905 the practice commenced of sending the bedding of *all* cases admitted to hospital, to be disinfected, so as to be on the safe side. The kit has been kept in company store in the two kit bags, and has not been sent for disinfection; nor have the dirty articles of clothing been washed, until the man's discharge from hospital.

Royal Dublin Fusiliers (St. George's).—Until the latter part of August only the bedding of cases of Mediterranean Fever was sent to hospital for disinfection; cloth articles of clothing were exposed to the sun and brushed; khaki, under-clothing, etc., was left in the kit bag *in situ* in company store. Since the beginning of September everything has been sent to be disinfected.

Rifle Brigade (St. Andrew's).—Same as Dublin Fusiliers.

From the above account it is obvious that the disinfection of the clothing and bedding of Mediterranean Fever patients has been, during the greater part of 1905, far from complete. The want of uniformity in procedure is remarkable. Assuming that infective material may be present in soiled sheets, blankets, shirts, trousers, etc., there must have been opportunity for dissemination amongst the men of the same company, or unit, in many cases. In those instances where bedding (including blankets) has not been disinfected, it has been possible for the blankets or other articles, that have been given into store by one man, to have been taken into use by another man, as it is not the general practice to label the blankets, etc., individually; the company storeman would return to a man on discharge from hospital the same blankets that he had deposited in the store on admission, if he knew which they were; but this would not always be the case. In the instances when bedding has been sent to be disinfected on instructions being issued to this effect, there was generally an interval of a week or 10 days before the instructions arrived; and during this time infection might be transferred to other blankets or bedding in contact with the infected articles. In those cases where the kit was not sent for disinfection, when the kit-bag was subsequently opened out, and any dirty shirts, etc., sent to the wash, there would be a chance of disseminating infective material. It is to be noted that, when a man goes to hospital, he generally puts on a clean shirt, etc., the dirty shirt, etc., going into his kit-bag. There is therefore some presumption that infective material might be present. When the washing day came round, sheets and pillowslips would be sent to the

wash; the dirty shirt, etc., might be sent to the wash, but it would more likely remain in the kit-bag until the owner came out of hospital.

As there were 487 cases of Mediterranean Fever during the period under review, and therefore 487 bundles of bedding and kit to be handled, one would expect that if these articles were infective, the "company store men" who handle them would show some increased liability to contract the disease. But in only one case could I ascertain that a storeman had been attacked. This was Private Burch, Essex Regiment, who was admitted to hospital on June 3, 1905. He stated that it was his duty to handle the clothing and bedding of Mediterranean Fever patients, and that sometimes this had been offensive, especially after having been fastened up in a bundle for some time.

It would seem to be probable that infection might be conveyed through infective fomites; and if this be the case, the measures of disinfection that were taken—up to September—could not be supposed to prevent this dissemination, looking at the whole question broadly. If a comparison however be made between the severity of incidence in the different corps and the method of treatment of presumably infected kit and bedding, it is seen that there is no general relation between the completeness of the disinfection and the severity of the attack ratio.

	Attack ratio per 1000.
Kit and bedding disinfected—	
R.G.A., 65th Company, Upper St. Elmo	83
,, 96th ,, ,,	69
,, 102nd ,, Tigne	32
Lancashire Fusiliers, Lower St. Elmo	63
Hampshires, Verdala	27
Kit disinfected, not bedding—	
R.G.A., 5th Company, Ricasoli	34
Bedding disinfected, not kit—	
R.G.A., 63rd Company, Ricasoli	18
,, 100th ,, ,,	42
Essex, Imtarfa	88
R.W. Kent, Floriana	45
Bedding disinfected, kit sunned and brushed—	
Dublin Fusiliers, St. George's	46
Rifle Brigade, St. Andrew's	54
Sometimes kit, sometimes bedding, sometimes both, disinfected—	
R.G.A., 1st Company, Tigne	68
,, 99th ,, ,,	54

Systematic and complete disinfection has been carried out in all cases, I believe, since the middle of September, 1905.

§ 8.

The discovery by Horrocks and Kennedy of *Micrococcus melitensis* in considerable numbers in the stomach contents of two species of mosquito (*Culex pipiens* and *Stegomyia fasciata*) indicates that transmission through the medium of biting flies is a possible mode of propagation. The arguments in favour of direct contagion or aërial transmission would apparently hold good equally in regard to mosquitoes, as carriers of infection, in places such as Malta, where they abound. Granted the presence of infective material in a ward or barrack room, in the shape of hospital patients or ambulatory cases of the disease, transference to the healthy in this way becomes easily intelligible; the numerous localised outbreaks are explicable on this hypothesis, as reasonably as by direct or semi-direct contagion. The only contribution that I am able to offer to this part of the subject is to mention that, of 97 patients from whom a *definite* statement was obtainable as to their experience of mosquitoes, 31 asserted positively that they have never, or practically never, been bitten at all; 18 stated that they had been bitten very slightly; while 48 admitted that they had been bitten a good deal. Without attaching much value to these statements (which, however, I believe to be accurate as far as they go), bearing in mind the rarity with which *Micrococcus melitensis* has been found to be present in the mosquito (four times in 896 individual mosquitoes), the chances seem to be very much against the entrance of the germ into the body having taken place in this way in the case of the 49 men who were either bitten but very slightly or not at all. But the number of men dealt with is insignificant.

Section IV.—Conclusion and Recommendation.

The chief facts ascertained in this enquiry into the prevalence of Mediterranean Fever amongst the troops in Malta have been summarised in Section III, § 1; the various modes of propagation of the disease that have been suggested by different observers have been considered in order, and, on the evidence of the facts ascertained, a negative conclusion as to their ability to explain the behaviour of this epidemic has been arrived at in regard to transmission (1) by water, (2) by milk or other articles of food, (3) by air contaminated with excremental (fæcal or urinary) effluvia; transmission (4) by direct or semi-direct contagion, or (5) through the agency of mosquitoes appears from the evidence to be more probable than in any other way; it is difficult to separate these two modes of dissemination, the one from the other, under the circumstances existing in Malta, and provisionally I think they may be considered together.

Fully admitting that no proof has been afforded in support of this opinion, I still consider that there is a high degree of probability attaching to it, and one quite sufficient to warrant the adoption of certain measures of prevention or precaution.

Whatever view be taken of the mode of propagation, the fact is undoubted that certain barracks have suffered much more than others; among these are Lower St. Elmo, Upper St. Elmo, and the old barracks at Floriana.

If considerations of economy and the maintenance of the health of the troops were the only things to be considered, probably the cheapest and most healthful course to pursue would be to evacuate these barracks altogether. If military considerations render this impracticable, I consider that an efficient alternative would be afforded if the following procedure were carried out :—

(1) Let it be recognised that these casemate barracks are entirely exceptional in their construction and need to be specially dealt with; the occupancy should be reduced from the present numbers (calculated on a cubic space of 600 cubic feet or less per head) to one which would allow 750 cubic feet *at the very least* per head, as is now admitted to be necessary in the case of all new barracks in the command. No height above 12 feet should be reckoned as available for ventilation in the calculation of this space.

(2) During the summer months tentage for 25 per cent. of the occupants of Lower St. Elmo should be drawn (as is the case in all the other barracks in Malta, except Imtarfa and Pembroke), so that the condition of the barrack rooms at night may be alleviated as much as possible in regard to heat, stuffiness and organic contamination of the air.

(3) As even under the best possible conditions, change of the air in these casemate barracks is very difficult, and accumulation of impurities on the walls and ceilings therefore much greater than in barracks of ordinary construction, all walls and ceilings of rooms and passages should be limewashed at frequent intervals, say, once a month; this would ensure the removal of dirt, the extermination (for the time) of mosquitoes, and, for practical purposes, would be a disinfectant measure. As the work could be done by the troops, the expense would be insignificant.

(4) There is sufficient evidence to warrant a presumption, at any rate, of localised infection, or semi-direct contagion: in the event of two cases of Mediterranean Fever occurring in the same room within a fortnight, the barrack room should be evacuated and limewashed, the men being accommodated in tents for the time; after this has been done, the room might be re-occupied; but if another case occurs within a fortnight of re-occupation, it should be again evacuated, and the body of men isolated as far as possible.

(5) If in any company, or small detachment, several cases occur in quick succession (*e.g.*, two in one week, or three in a fortnight) this body of men should be regarded as infected. They should be placed under canvas, or transferred elsewhere; the measures suitable for each individual outbreak of this kind can be decided on according to the special circumstances of each case. The remarkable freedom from fever experienced by the Gozo detachments of the Essex Regiment (which regiment suffered so severely at Lower St. Elmo) indicates that, if any small infected body of troops were removed from their surroundings to a detached spot (*e.g.*, Gozo, or Mellieha, etc., etc.), and scrupulous attention paid to their sanitation in every detail, the infection may be expected to die out. Once it is evident that a body of men is infected, the sooner the move is made the better; probably a very short distance would suffice; but there must be no over-crowding, and every detail of sanitation must be carefully attended to. The rooms evacuated should be fully disinfected with formalin or other disinfectant.

(6) The above recommendations refer especially to the three old barracks that have suffered severely from Mediterranean Fever; there are other old barracks of similar defective construction to which the same recommendations are applicable, though Mediterranean Fever has not been especially prevalent in them during the past year. Such are St. James Cavalier, Salvatore Counter Guard, St. Francis Barracks, Marsamuscetto, Old Laboratory, all the barracks in the Cottonera Lines, and Fort Chambray, Gozo. In all of these the recommendations as to 750 cubic feet of space per head, 12 feet of height only being reckoned for the calculation of space; frequent limewashing, and evacuation and disinfection on the occurrence of Mediterranean Fever, equally apply. Although they have not suffered in 1905, their defects are such that a prevalence of the disease is to be feared, if the infection be introduced in sufficient amount. Tentage is already authorised to be drawn for these barracks in the hot weather.

(7) In the modern barracks in Malta, which are so satisfactory in their construction and general sanitary conditions, the above recommendations do not appear to be necessary; but the principle of a stitch in time equally holds good; any succession of cases in a barrack room would indicate the advisableness of evacuation, disinfection, and isolation.

(8) The defects in the supply of water for sanitary purposes throughout the Cottonera district (including Verdala), at St. James Cavalier and at St. George's require immediate attention. The provision of an ample supply of sea water, or No. 2 water, in order to flush the latrines and drains properly is such an obvious necessity, that it is strange that a recommendation to this effect should require to be made. Increased pumping power appears to be what is wanted;

but this is a matter for the Royal Engineer department to determine. The necessity is urgent. Latrines should be flushed at least three times a day, and four times a day if water is available.

(9) The management of urinals has not been properly carried out: systematic application of "heavy oil," or some efficient substitute (such as colza oil and tar, as used at Imtarfa); the omission of water flushing for the stalls (which, strangely enough, has very generally been used along with the oil treatment); but the careful washing of the floors of urinals, and flushing of the urinal drains with water; these are the measures indicated.

(10) Where the dry-earth system of excreta removal is still in use, a removal of three times, instead of once, in the 24 hours is recommended: this will necessitate the provision of suitable receptacles for the pail contents. The present system is too barbarous and offensive to be tolerated. There is no reason why what is strictly forbidden in India should be universally permitted in Malta: I refer to the retention in the latrines of pails, full of filth, for the greater part of the 24 hours. The nearest approach possible to the *immediate* removal system (according to the Indian fashion) should be made. It is to be hoped that the dry-earth system will, before long, be completely abolished in Malta, except for temporary camps.

(11) If the above recommendations (8) to (10) are carried out, it is to be expected that the contamination of the air of barracks generally by excremental emanations, also the risks due to disease conveyance by flies, will cease; until this is the case no barrack can be considered to be in a good sanitary condition, whether in reference to Mediterranean Fever or any other infectious disease. There is one special preventive measure directed against Mediterranean Fever infection that has been carried out during the past year, viz., the boiling or "pasteurising" of milk for the troops. This requires to be continued in the strictest possible manner. As regards the married families, for whom this is more important than for the troops, it might be feasible to provide Aymard sterilisers to treat the milk supply of the large married quarters centrally, and therefore more effectually. If this is impracticable, special instruction and warning should be continually given, not only to new arrivals, but to all the married people, as to the necessity for sterilising goats' milk, or else substituting condensed milk for it.

(12) As success in dealing with this disease, as in other infectious fevers, will probably largely depend on stopping the beginnings of an outbreak, *i.e.*, carrying out the principle of *Obsta principiis;* perhaps the most important thing of all is to find out as early as possible when and where anything like an epidemic prevalence is commencing. The existing arrangements for arriving at a diagnosis are satisfactory; if, however, this could be expedited, it would be very desirable that it

should be done. But what is required, in my opinion, is some method of tracking out the cases as soon as they occur; not waiting for a final diagnosis, which cannot be arrived at for perhaps 10 to 14 days, but, examining the patient, his surroundings, habits, movements, etc., etc., whenever there is even a *probability* of the case being one of Mediterranean Fever. Information can be easily obtained at the time, which afterwards can only be got at with difficulty and labour, or not at all. The existing establishment of medical officers is not, in my opinion, adequate for this work, they being all fully employed, as it is, especially during the summer months, when the sickness is greatest. I consider, and recommend, that two extra medical officers be employed, to give their whole time to this epidemiological investigation work, over and above the work that has been hitherto, and is now being done in the laboratories and in the various hospitals. The tracking out of the early cases by a skilled observer ought to lead to important results, in the way of ascertaining modes of infection, and consequently the carrying out of effectual measures of prevention. I do not think that one medical officer would be sufficient, the ground to cover is too extensive, and the investigations must be undertaken without delay in each case; in the summer months at least two officers would be busily occupied every day. They should be employed for this purpose only.

(13) Immediate and effectual disinfection of clothing and bedding of men admitted to hospital with Mediterranean Fever, and of patients in hospital suffering from this disease, should be carried out as a matter of course. To be effectual the disinfection must be complete, not as was formerly the case.

(14) Isolation of Mediterranean Fever patients when in hospital is indicated. The difficulty is to carry it out at Valletta Hospital.

(15) The management of the Long Ward at Valletta Hospital, so as to ensure proper change of air, is a very difficult problem to solve. I am convinced that much more ventilation, a much more frequent and thorough change of air than has hitherto been the case, is required. More advantage might be taken than was the case last summer, of the existing windows in the upper storey. A new hospital is urgently required, as has been insisted on for about 30 years past.

XIV.—FURTHER MOSQUITO EXPERIMENTS.

(Continued up to the end of January, 1906.)

By Captain J. Crawford Kennedy, R.A.M.C.

(Received February 5, 1906.)

From the middle of October, 1905, until the number of mosquitoes obtainable was too small to be of experimental use, the following experiments were carried out:—

Experiment A.—Mosquitoes were collected from the mosquito nets of Malta Fever patients and the wards of Citta Vecchia Hospital; they were all without exception *Culex pipiens*, and had fed well during the previous night on the patients; they were placed in a cage (marked "A") over water and then given the opportunity of feeding each night on a monkey. A supply of mosquitoes was received daily, and from October 13 to November 12 between 600 and 700 were collected. The monkeys bitten were Nos. 93, 22, and 33.

Monkey No. 93.—This animal had been used by Major Horrocks during the summer in order to try to infect it by means of dust collected from various parts of the island and blown down its nostrils. The last time this experiment was performed was early in July, so that there was a clear interval of at least 2½ months during which there was not a trace of a reaction to the *Micrococcus melitensis* in its blood.

The mosquitoes in Cage A were placed on this monkey nightly (with a few exceptions) from October 16 to October 31, in all 11 times; and I consider that about 500 mosquitoes had a chance of biting during that time. The animal's blood was tested for reaction to *Micrococcus melitensis* on October 16, 22, and 29, and November 5, but with no result. On November 12 there was a faint reaction in a 1/10 dilution. On November 19 a faint reaction was also perceptible in 1/10 in half an hour, and this became quite distinct in one hour. On November 25 this faint reaction had disappeared; nor was any reaction obtained on the following dates: December 2, 10, and 17. On December 31 a faint reaction appeared again. On January 7, 1906, there was a more or less complete reaction in 1/20 in half an hour. On January 10 and 12, the same; but on standing for 1½ hours the reaction was complete in 1/80 and incomplete in 1/100. On January 21 the reaction had not increased and, fearing that it might again disappear, I chloroformed the animal on January 24 and made a careful *post-mortem* examination.

The glands in the femoral and the axillary regions were enlarged and more numerous than usual. The spleen and other internal organs were normal.

Cultures on plates were made from the following organs :—

Spleen—entirely cut up and impressed on five plates.
Liver—two plates.
Kidney—two plates.
Glands, mesenteric—four plates.
,, femoral—five plates.
,, axillary—four plates.

Micrococcus melitensis *was recovered from all the plates made from the axillary and the femoral glands. All the other organs were sterile.* The microbe was present only in small quantity ; the axillary contained more than the femoral glands.

Monkey No. 93 was, therefore, infected with *Micrococcus melitensis.* The fact that the microbe was localised so completely in the glands and had never reached the internal organs, probably explains the unsatisfactory nature of the agglutinative reaction.

The observation of the presence of a faint reaction 12 days after the last exposure to infection is important, (1) as proving the presence of the microbe in the body at that date, and (2) as showing that it had been there long enough to cause the formation of agglutinins ; otherwise the long incubation period before a complete agglutination was obtained might cast some doubt on the experiment.

The animal never had any rise of temperature.

There was no chance of the monkey becoming infected in any other way than by the bites of the mosquitoes. The conditions under which it lived were as follows :—

For the whole summer it lived in one box shut off from any possibility of contamination from infected animals by waterproof partitions. It was situated at the end of a row, so that there was no animal on its left side. The box on its right was always occupied by an uninfected animal. No animal contracted the infection accidentally during the year. On December 14 it was removed along with three other uninfected monkeys (mosquito experiments) to a mosquito-proof room in the Lazaretto which had previously been carefully disinfected and whitewashed. These three other monkeys show no sign of infection.

Monkey No. 22 was only bitten three times and was never infected. It died from tuberculosis.

Monkey No. 33 arrived in October from Bombay, and was kept under observation till November 2. On that date and regularly till December 11 the mosquitoes in Cage A were fed on it. The cage was put on 27 times altogether, and I estimate that about 100 mosquitoes had a chance of biting.

The monkey has up to date never showed signs of reacting to *Micrococcus melitensis.*

Experiment B.—Mosquitoes caught promiscuously and presumably

uninfected were placed in Cage B, with water in which *Micrococcus melitensis* was held in suspension. They were fed regularly on Monkey No. 36 between November 11 and December 11.

Monkey No. 36 has never up to date showed signs of reacting to *Micrococcus melitensis.*

Experiment C.—Freshly-hatched *Culex pipiens* were collected in Cage C, and kept alive by feeding them alternately on an infected and an uninfected monkey.

Between November 3 and December 11 they were fed on Monkey No. 101 twice, on Monkey No. 27 14 times (both these monkeys were infected and contained *Micrococcus melitensis* in their blood), and on Monkey No. 14 (uninfected) 12 times.

Monkey No. 14 has up to date never shown signs of reacting to *Micrococcus melitensis.*

Summary.

I. *Monkey No. 93 became infected with* Micrococcus melitensis *as the result of bites from mosquitoes* (Culex pipiens) *which had fed on patients suffering from Malta Fever.*

II. An attempt to infect a monkey by means of bites from artificially infected mosquitoes failed.

III. Attempts to convey infection from an infected to an uninfected monkey by means of freshly-hatched mosquitoes (*Culex pipiens*) were unsuccessful.

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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART V.

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February, 1907.

CONTENTS.

I. EXPERIMENTS WITH MONKEYS ON VARIOUS POSSIBLE PATHS OF INFECTION IN MEDITERRANEAN FEVER.

By Staff-Surgeon E. A. SHAW, M.B. Cantab., Royal Navy.

THE major portion of the following experiments were undertaken pursuant to suggestions made by the Advisory Sub-Committee and received by me in December, 1904. As some of them are merely repetitions of experiments already reported by members of the Commission, it is hardly necessary to describe these with great wealth of detail.

I. WITH DUST INFECTED WITH *Micrococcus melitensis* DERIVED FROM SPLEEN CULTURES.

The dust was prepared by grinding up and sterilising yellow Sliema soil, a layer of which, 3/16 of an inch deep, was saturated with the emulsion obtained from one agar slope of a seven-day growth of *Micrococcus melitensis*, second generation from human spleen. This was then dried in incubator and plated to determine presence of living *Micrococcus melitensis*; then carefully powdered and used as described.

(a) *Monkey Placed in Air-tight Box and Artificial Dust Storm Created.*

The infected dust was placed at the bottom of a filtration flask which was fitted with a rubber cork through which passed a glass tube, one end of which almost touched the bottom, the other end being connected by rubber tubing with the nozzle of a pair of bellows; a side tube from the upper portion of the flask was fitted with another piece of rubber tubing which was passed into the interior of an air-tight tin box with one glass side, the orifice of entry for the rubber tube being luted with cotton wool. The monkey was enclosed in a bag with a draw-string round its neck and placed with its face in direction of the dust, which issued on gently using the bellows, which were kept going for 20 minutes, the monkey allowed to remain 10 minutes longer, then removed and everything disinfected.

Monkeys No. 64, in December, and No. 48, January, 1904–5, were each subjected to this procedure once and once only, the intention being to obtain definite information as to their incubation period for this form of infection should the experiment succeed. Both monkeys had been under careful observation prior to the experiment and neither had ever given the slightest indication of fever, either by rises of temperature or in response to frequently repeated serum agglutination tests.

Result.—Neither monkey became infected.

(b) *Infected Dust Blown up Monkeys' Nostrils.*

A piece of glass tube of about 1/8 of an inch diameter was taken, one end made conical and rounded off in the Bunsen flame, about half a gram of infected dust placed in it, the larger end connected by a rubber tube lightly plugged with cotton wool to the bulb of an enema. The monkey was held by an assistant, the conical end of the dust-containing glass tube placed in one nostril and pressed in till an air-tight junction was effected between the two, then compression of the rubber enema bulb puffed the infected dust into the nasal cavity. The plug of cotton wool above mentioned functioned as a non-return valve and prevented infected dust regurgitating into the enema bulb. The presence of living *Micrococcus melitensis* in the dust was proved by plating it out each time it was used.

Monkeys Nos. 65, 77, and 103 were subjected to this procedure.

Monkey No. 65.—On December 29, 1904, was so treated. Prior to this its temperature was being taken and the agglutination reaction examined for frequently; this was first obtained in a dilution of 1 in 20, January 14; in a dilution of 1 in 40, February 16; in a dilution of 1 in 400, February 18. Its first wave of temperature did not begin till February 8, and only lasted till the 14th, inclusive, that is seven days; this would give an incubation period up to the first rise of temperature of 40 days. On February 14, blood was taken aseptically from the saphenous vein of right leg (the manner of doing this will be described under "immunity" experiments); incubated in broth for seven days, then sub-inoculated on to agar slopes, whence *Micrococcus melitensis* was recovered and verified three days later. This animal was later used for immunity experiments.

Monkey No. 77.—Arrived from Calcutta, March 3, 1905. Dust prepared as above described and blown up nostrils April 26, 1905. This monkey never presented any agglutination reaction or fever. It died of diarrhœa June 9. The customary *post-mortem* inoculation of plates and tubes from organs, etc., were made. No *Micrococcus melitensis* was recovered.

Monkey No. 103.—Arrived from Calcutta, March 3. Dust prepared as above described and blown up nostrils once a day for five days, from June 29 to July 3, inclusive; the reason for repeating this procedure five times was that this monkey had a trick of shutting off its nasal cavity from its pharynx, so as to make a closed chamber of the former which greatly interfered with, practically prevented in fact, the puffing of the dust into its nostrils, so that a satisfactory dose was not administered till the fifth day.

The agglutination reaction was first obtained August 3, 1 in 30, was 1 in 160 August 6, and 1 in 800 August 10, and 1 in 2,000 August 20. It presented no distinct wave of fever till August 10, when its evening

temperature went up to 103°, remaining at or above this till the 19th, when it gradually descended; this would give an incubation period from July 3 to August 10 of 38 days. Blood was taken from vein of leg, as in Monkey No. 65, on August 11, put in broth and incubated. *Micrococcus melitensis* was recovered and verified from this on August 23. During September this monkey suffered with bad diarrhœa, dying on September 30. The usual inoculations of plates and tubes made *post-mortem* failed to yield any *Micrococcus melitensis.*

Result.—Two monkeys out of three thus experimented on became infected, the infection being absolutely proved by the recovery of *Micrococcus melitensis* from their blood during life, the incubation periods being respectively 40 and 38 days.

(c) *Infected Dust Placed in Conjunctival Sacs.*

Four monkeys experimented with, Nos. 76 and 78 old series, and 28 and 29 new series. In each before experimentation the eyes were tested with a solution of fluorescin and carefully examined for conjunctival scratches and abrasions; none were found. The monkey being held by two assistants, with one's left fingers the two eyelids were separated, and with the right hand a little of the infected dust was dropped from a small spatula into the conjunctival sac, the eyelids being kept apart until the dust was thoroughly saturated with tears, and then the animal was released.

Monkey No. 76.—Dust dropped into eyes January 23, 1905; the animal died of diarrhœa February 7; there had been no agglutination reaction or rise of temperature during this period. A very large number of plates and tubes were inoculated from the various organs *post-mortem*, but no *Micrococcus melitensis* was recovered.

Monkey No. 78.—Infected dust dropped into eyes on May 6, 1905; May 31, 1905; June 29, 1905; August 6, 1905; August 26, 1905. This animal's serum was examined twice a week for agglutination reaction up till October 15, invariably with a negative result; its temperature was recorded twice daily during the whole period, but there was never any rise of temperature.

Monkey No. 28.—Infected dust dropped into eyes daily for a week commencing October 29, 1905. Agglutination was first found November 19, 1 in 30, and was 1 in 600 November 26. A wave of temperature commenced November 8, with 104° F. (I should put the incubation period here 4 to 10 days), and lasted till the animal's death on November 28. Blood had been taken from its right saphenous vein the day before, November 27, and incubated in broth. *Micrococcus melitensis* was recovered and verified from this on December 7. At the *post-mortem* there was found purulent peritonitis of pelvis and lower part of abdomen. The usual inoculations were made, and on December 1 *Micrococcus melitensis* was found and verified in innumer-

able colonies in the axillary and femoral lymphatic gland plates, and also in the spleen; there were many fewer *Micrococcus melitensis* colonies in the liver plates and fewest of all in the kidney plates.

Monkey No. 29.—Infected dust dropped into eyes daily for a week commencing October 29, 1905. Agglutination reaction first present on November 12, 1 in 30, was 1 in 400 November 19, and 1 in 1500 on November 26, rising to 1 in 2000 on December 10, after which it fell away, being 1 in 1000 on December 24, 1 in 800 January 14, 1906, and 1 in 400 on January 28. The first wave of temperature began November 20 and lasted till November 28, thus giving an incubation period of 16 to 22 days. Blood was taken from right saphenous vein on November 21, incubated in broth and sub-cultured on agar. *Micrococcus melitensis* was thus recovered and verified November 30. The animal was placed in a cage with an uninfected monkey (131), separated from it by wire netting as a limited contact experiment, on November 22. It developed acute diarrhœa on January 28 and died on the 30th. The usual *post-mortem* inoculations were made from organs and lymphatic glands and *Micrococcus melitensis* was recovered, four colonies only in one plate from a left axillary lymphatic gland.

Result.—Monkeys Nos. 76 and 78 negative. Monkey No. 28 was infected, incubation period 4 to 10 days. Monkey No. 29 was infected, incubation period 16 to 22 days.

II. With Dust first Saturated with Mediterranean Fever Patient's Urine, Naturally Containing *Micrococcus melitensis*, then Dried and Blown up Monkeys' Nostrils.

Four monkeys thus treated. The urine made use of was that from ambulatory Cases 9 and 11 (see Vol. IV of these reports). These two urines have been collected and plated out continuously twice weekly since August, 1905, and have never failed to contain living *Micrococcus melitensis* up to time of writing (end of April). Small quantities of sterile dust were placed in watch glasses, saturated with the urine and dried in the incubator, and this was blown up the monkeys' nostrils in the manner already described (Section I (b)).

Monkey No. 104.—Received from Genoa, July 12, 1905. Kept under observation and blood examined for agglutination reaction.

July 25. Dust prepared as described and blown up monkey's nostrils; this was repeated daily till August 27.

August 28 to October 3. Urine dust not administered.

October 4 to November 5. Urine dust daily administered.

November 6. Very seedy.

November 7. Obviously dying. Chloroform given.

Post-mortem made, usual inoculations from all organs and lymphatic glands. No *Micrococcus melitensis* was recovered. During the whole period of the experiment the blood was examined twice a week for

agglutination reaction which never appeared, nor was there any wave of temperature.

Monkey No. 106.—Received from Genoa, July 12. Treated in precisely the same manner as Monkey No. 104, commencing July 25 and repeated daily till the 29th. Unfortunately the animal developed violent diarrhœa and died on July 31. The usual *post-mortem* inoculations from organs and lymphatic glands were made but no *Micrococcus melitensis* was recovered. There was never any agglutination reaction or fever.

Monkey No. 25.—(New Series). Received from Calcutta, October 18, 1905. From October 29 to November 24 Mediterranean Fever urine dust was blown up nostrils daily, then intermitted because of development of diarrhœa.

November 28, 1905, to March 13, 1906, Mediterranean Fever urine dust blown up nostrils daily between these two dates, and then suspended.

During the whole of this time, October to March, periodical examinations for agglutination reaction were being made (once a week) and the temperature was being twice daily recorded. There was never any agglutination reaction present and there was never any fever.

Monkey No. 35.—Received from Calcutta, October 18, 1905. November 8 to November 24 urine dust blown up nostrils daily. November 25 to November 28. This suspended because of diarrhœa.

November 29 to December 24. Urine dust blown up nostrils daily, then again suspended five days.

December 29 to March 4. Urine dust blown up nostrils daily.

March 5 again suspended. Monkey seedy.

March 11. Has developed acute diarrhœa.

March 13. Died.

As with No. 25, agglutination reaction had been examined for weekly during the whole period but had never been present. Temperature had been recorded twice daily but there had never been any fever. The usual *post-mortem* inoculations of plates and tubes from organs and lymphatic glands were made immediately after death, incubated and carefully examined for *Micrococcus melitensis*, but none was recovered.

Addendum.—Monkey No. 25 died, without obvious cause or discoverable *post-mortem* lesion, on April 5, 1906. It was very thin and emaciated. The usual *post-mortem* inoculations from all organs and lymphatic glands were made, but no *Micrococcus melitensis* was recovered.

Result.—Thus of four monkeys experimented with as described, none became infected from dust contaminated with urine naturally containing *Micrococcus melitensis.*

III. Contact Infection.

(a) LIMITED CONTACT *in mosquito-proof hut between an Infected and an Uninfected Monkey living in same box on a bottom of wire netting and separated by a vertical wire netting partition, and Possible Infection by Urine and Mosquitoes Excluded, Infection by Skin and Skin Parasites possible.*

Monkey No. 81.—Was kept under observation eight days for temperature and agglutination reaction, and then on May 30, 1905, placed as above with Monkey No. 79 which, on May 15, had received a subcutaneous injection of living *Micrococcus melitensis* and which on May 30 presented an agglutination reaction of 1 in 800 and was in a wave of fever. Monkey No. 79 died on June 4, and *Micrococcus melitensis* was recovered *post-mortem* from its spleen. In order to ascertain approximately incubation period, should infection occur, Monkey No. 81 was left to live alone in his box, under observation for fever and agglutination reaction. Neither having presented themselves by July 20, on this date, Monkey No. 80 (whose blood had been proved by culture in broth to have contained *Micrococcus melitensis* on July 11) was placed in the compartment formerly occupied by Monkey No 79. On August 6, Monkey No. 81 developed diarrhœa, which in spite of treatment got worse, this monkey dying on August 19. The usual *post-mortem* inoculations from organs and lymphatic glands were made and incubated, but no *Micrococcus melitensis* was recovered; both temperature and blood were under continuous observation, but there was never any fever or agglutination reaction.

Monkey No. 131.—A normal, uninfected animal was, on August 29, placed in one compartment of same box (which had previously been thoroughly disinfected) with in the other compartment Monkey No. 118, a milk *Micrococcus melitensis* infected monkey, whose blood had been demonstrated by culture in broth to have contained *Micrococcus melitensis* on August 12, and which was in a wave of fever and presented an agglutination reaction of 1 in 1000 on August 27. The two monkeys remained in same box till October 18, when the infected one (No. 118) died of acute diarrhœa, *Micrococcus melitensis* being recovered from one femoral gland *post-mortem*. Monkey No. 131 now remained alone till November 22, when Monkey No. 29 (new series) was placed in the compartment vacated by Monkey No. 118; Monkey No. 29 had been infected by placing dust containing *Micrococcus melitensis* into its eyes, and *Micrococcus melitensis* had been demonstrated to have been present in its blood on November 21 by culture in broth. These two monkeys remained together till January 3, 1906, when Monkey No. 131, which had previously developed diarrhœa, died. The usual *post-mortem* inoculations of plates and tubes from organs and glands were made and incubated, but

Micrococcus melitensis was not recovered; the animal had been under continuous observation for fever and agglutination reaction, but never presented either. Its companion (Monkey No. 29) died January 30, 1906, and *Micrococcus melitensis* was recovered *post-mortem*.

(b) FULL CONTACT *between an Infected and an Uninfected Monkey living in same box, Mosquito Infection alone Excluded.*

Monkeys Nos. 82 and 115 were the uninfected monkeys thus experimented on.

Monkey No. 82.—Kept under observation for eight days for temperature and agglutination reaction, then placed, on May 30, 1905, with Monkey No. 80, which, on May 15, had received a subcutaneous injection of *Micrococcus melitensis* and on May 29 was in a wave of fever and presented an agglutination reaction of 1 in 3000, *Micrococcus melitensis* being recovered from its blood in July, 1905.

Monkey No. 82, on July 9, first presented agglutination reaction in a dilution of 1 in 40, which had risen to 1 in 1000 by July 23, but it never presented any distinct wave of fever, its temperature never rising above 102°·6 F. On July 15 blood was taken aseptically from the right saphenous vein of Monkey No. 82, incubated in broth, and on July 23 *Micrococcus melitensis* was recovered and verified from this. On August 2 this animal was lent to Major Horrocks to be used for mosquito-infection experiments at Lazzaretto. In October its agglutination had fallen to 1 in 80 and to 1 in 20 in November.

Monkey No. 115.—Arrived from Genoa, July 12, 1905. Kept under observation for agglutination reaction and temperature till July 20, when it was placed in same cage, in full contact under mosquito-proof conditions, with Monkey No. 100, which on June 28 had received a drop of emulsion of *Micrococcus melitensis* in the eye, and whose blood on July 18 had been proved to contain *Micrococcus melitensis*, and which on July 20 was in a wave of fever and presented an agglutination reaction of 1 in 1500. These two animals lived together till November 1, when Monkey No. 115 never having presented the slightest indication of infection, Monkey No. 100 was taken out of the box and replaced by Monkey No. 27 (new series) which was just commencing a wave of fever, having received a subcutaneous injection of *Micrococcus melitensis* on October 25 and whose blood was demonstrated by broth culture to have contained living *Micrococcus melitensis* on November 1. Monkeys No. 115 and 27 lived together till the death of the latter on March 2.

Monkey No. 115 had never presented any wave of fever or agglutination reaction from July 20, 1905, to March 20, 1906, during which period its temperature had been recorded twice daily and its blood examined for agglutination reaction to *Micrococcus melitensis* once weekly.

Result.—Limited contact experiments on two monkeys, Nos. 81 and 131; neither infected.

Full contact experiments on two monkeys; Monkey No. 82 was infected as evidenced by recovery of *Micrococcus melitensis* from its blood during life, incubation period impossible to determine. Monkey No. 115 was not infected. I consider Monkey No. 82 as almost certainly infected through the urine of Monkey No. 80. In the winter of 1904–05 I caused partitions to be placed separating and isolating the boxes for monkeys on the terrace, a plan of which is given in Vol. I of these reports. The floor of the terrace is concrete cement, and so each partition was embedded in cement at its junction with the floor. The object of this was to eliminate the possibility of accidental infection through urine. So far as I know not a single monkey has been infected save as the result of purposeful experiment since this was done.

IV. Infection through various Mucous Membranes with Emulsion of *Micrococcus melitensis* derived from Human Spleen Growths and Dropped into

(a) *Conjunctival Sac.*

In these experiments, to ascertain as far as possible that one was attempting to infect through an unbroken mucous membrane, and not through a scratch in it, a solution of fluorescin was first applied in the manner familiar in ophthalmic practice, and the mucous membrane carefully examined with a lens for staining of abrasions or scratches.

Two monkeys, 61A and 100 were both thus experimented on.

Monkey No. 61A—After being under preliminary observation to determine its freedom from infection, on December 19, 1904, it received in each conjunctival sac one drop of an emulsion in distilled sterilised water of a seven-day growth of second generation of *Micrococcus melitensis* from human spleen. Its temperature remained practically normal till the morning of January 3, when it was 103°, rising to 104° same evening, and being 106° on morning of January 4, returning, after describing a characteristic wave, to the normal on January 13. Agglutination reaction was first found on January 3 in a dilution of 1 in 40, on January 9 was 1 in 160, on January 16 1 in 1500. On January 14, blood was taken aseptically from right saphenous vein and incubated in broth; *Micrococcus melitensis* was recovered from this and verified in the usual way. The animal was later used for an immunity experiment. The incubation period here is obviously 15 days.

Monkey No. 100.—After preliminary observation, to determine freedom from infection, this animal received on June 28, 1905, into each conjunctival sac one drop of an emulsion of *Micrococcus melitensis*

derived from human spleen. On July 13 the agglutination reaction with *Micrococcus melitensis* was first obtained. On July 12 it commenced a wave of fever ranging about 104°, being therefore not so marked as in Monkey No. 61A. On July 16, blood was taken aseptically from its right external saphenous vein and incubated in broth; from this living *Micrococcus melitensis* was later recovered and verified. The animal was later also made use of for an immunity experiment. The incubation period here was 14 days.

Result.—Both monkeys experimented on became infected, the infection being absolutely proved by the recovery of *Micrococcus melitensis* from their blood during life, the incubation periods being respectively 15 and 14 days.

(b) *Emulsion of* Micrococcus melitensis *Dropped in Trachea.*

This was Experiment 22 suggested by Advisory Sub-Committee and allotted to me for performance. It was at first intended to use a small serum syringe with which to deposit the single drop of emulsion in the trachea, but on rehearsing the experiment so much uncertainty was felt owing to the inability to see the end of the column of fluid in the needle, and from the absence of a stop on the needle the risk of puncturing the opposite side of the trachea seemed so great, as to render it extremely likely that the primary condition of the experiment, which was that there should be no soiling of any wound surface with *Micrococcus melitensis*, would not be realised; the object being to ascertain possibility of infection and duration of incubation period in the case of unbroken tracheal mucous membrane. The method ultimately decided on was the following :—A sterile glass pipette was taken, and its fine terminal portion bent in the flame at a right angle about $1\frac{1}{2}$ inches from its point; the butt end of the pipette had been as usual lightly plugged with cotton wool and was now fitted with a piece of rubber tube provided with a mouth-piece; by suction the equivalent of two drops of sterile normal salt solution was drawn into the capillary portion of the pipette, then a bubble of air, and then the equivalent of one drop of emulsion of *Micrococcus melitensis*; thus one had in the capillary portion of the pipette two columns of fluid separated by a bubble of air; that nearest the thick end of the pipette being sterile salt solution, that nearest its terminal extremity, and hence the first to make its exit, being emulsion of *Micrococcus melitensis*, the terminal end of which column was arranged to coincide with the situation of the right angle already mentioned; these two columns were maintained motionless in the long capillary part of the pipette by putting a spring clamp on the rubber tube; and finally the middle of the $1\frac{1}{2}$ inch terminal part of the pipette was placed in the peep light of a Bunsen burner, and drawn out sharply very fine; this left a small shoulder, and the capillary filament was broken $\frac{1}{8}$th of an inch from this with a pair of

sterilised scissors, and thus the terminal fine end of the pipette was sterile. On rehearsing with this on a dead monkey, everything went satisfactorily.

The trachea below the larynx, which in the monkey is enclosed in the fused sternohyoid muscles of both sides, having been laid bare, the sterilised pointed extremity of the prepared pipette was passed between two rings of the trachea, being arrested with its point just inside the trachea by the little shoulder mentioned; the mouth-piece of the rubber tube being in the mouth a little air-pressure was got up and the clamp removed; the column of *Micrococcus melitensis* emulsion at once disappeared from sight, followed by the bubble of air and then by the column of sterile normal saline which was intended to wash away traces of the *Micrococcus melitensis* emulsion from the tip of the pipette and so prevent its soiling the puncture of entry on withdrawal. The experiment as described was performed on Monkey No. 48 (which had been subjected to the usual preliminary observation) under chloroform on January 31, 1905, the animal being placed on a board sloping at about 30° from the vertical so as to allow gravity to act on the fluid injected into the trachea. The operation wound had healed on February 6. It was examined periodically for agglutination reaction, which first appeared on February 16 in a dilution of 1 in 320, rising to 1 in 3000 on February 20. A wave of temperature began on the evening of February 15, when it was 103°, ascending daily till it was 106° on February 20, thus giving an incubation period of 15 days. On February 21 blood was taken aseptically from the right external saphenous vein and incubated in broth. *Micrococcus melitensis* was thus recovered and verified. The animal seemed to fully recover and be quite well during second week in March, but on March 15 was very ill and died on the morning of March 16. The usual *post-mortem* inoculations of plates and tubes from the various organs were made, and *Micrococcus melitensis* was recovered, but from the spleen only. At the *post-mortem* there was no trace of the operation save the scar in the skin; all had healed; there was a good deal of frothy mucus in the trachea, and both lungs were hepatised; inoculations from these yielded a Gram-staining, acid-producing coccus which was not further investigated.

Result.—Monkey No. 48 was infected through the mucous membrane of the trachea, the infection being proved by the recovery of *Micrococcus melitensis* both during life and after death, the incubation period being 15 days, similar to that in the case of the two monkeys infected through the conjunctival mucous membrane.

(c) *Emulsion of* Micrococcus melitensis *Dropped into Nostrils.*

Monkey No. 118 was received from Genoa, July 12, 1905, was kept under observation for temperature and agglutination reaction till

July 20, when, being free from infection, it was held on its back and three drops of an emulsion of *Micrococcus melitensis*, derived from the milk of No. 2 Bighi Goat of July 13, was dropped into each nostril, the position of the monkey's head being such as to allow this to trickle over the turbinate bones. Its blood was frequently examined for agglutination reaction, which first appeared on August 3 in a dilution of 1 in 30, rising to 1 in 320 on August 6 and 1 in 960 on August 10. It commenced a wave of fever on August 3, when its evening temperature ran up to 104°, being on August 4 104°·6, and on August 5 105°, thus giving an incubation period of 14 days. Blood was taken aseptically from its external saphenous vein on August 12, and was incubated in broth. *Micrococcus melitensis* was recovered and verified from this. During September and October the animal suffered intermittently from diarrhœa, ultimately dying on October 18. The usual *post-mortem* inoculations of plates and tubes were made, and *Micrococcus melitensis* was recovered and verified, but only in small quantity, four colonies from one femoral lymphatic gland.

Result.—Monkey No. 118 was infected through the nasal mucous membrane, as proved by the recovery of *Micrococcus melitensis* during life and after death, the incubation period being 14 days, similar to that in the case of infection through the conjunctival and tracheal mucous membranes.

V. Infection by Mosquitoes.

Monkey No. 76, uninfected, had been subjected by Major Horrocks, on September 22, 27, and 29, 1904, to the bites of mosquitoes which had 48 hours previously fed on an infected monkey, after which the animal was turned over to me for continuance. The method I adopted was to place four mosquitoes—all procurable varieties being utilised—in a large pill box with a glass top and a coarse gauze bottom; two sets of six of these boxes were used. The insects were first applied to the hypochondriac regions of the infected monkeys (Monkey No. 60A subcutaneously injected September 16 and Monkey No. 72 food-infected September 19), kept there till at least three of the four in each box had fed, the date and monkey's number noted on the rim of the box, which was then placed in the dark for 48 hours, after which it was brought out and applied to the uninfected monkey till feeding had taken place. The object of having two sets of six boxes was to enable one to apply presumably infected mosquitoes every two days instead of every four. Whenever all the mosquitoes were dead another box was commenced with insects obtained from the Central Civil Hospital ward in which the Mediterranean Fever cases were accommodated. Some of the mosquitoes, generally *Stegomyia fasciata*, would live as long as four weeks, alternately feeding on the uninfected and the infected monkeys, Culex seldom more than four or five days.

The experiment as described was continued by me for just over two months till December 1, when it had to be discontinued owing to the difficulty of obtaining and keeping the mosquitoes alive. Monkey 60A was not used for infecting mosquitoes after the end of September. The infectivity of Monkey No. 72 was kept up by subcutaneous injections of living *Micrococcus melitensis* on October 18 and November 10, and this organism was recovered and verified from its blood on October 10 and 24 and November 6 and 21. The temperature of Monkey No. 76 was recorded twice daily, and its blood examined once weekly, but up to the date of its death on February 7, 1905, it never presented any fever or agglutination reaction, nor was any *Micrococcus melitensis* recovered from its organs *post-mortem*. (It was used for an abortive dust experiment from January 27 to February 7.)

Result.—Negative. Monkey No. 76 remained uninfected.

VI. To Determine Infectivity of Sea Water Fouled with Sewage.

Monkey No. 71, on which Major Horrocks had begun this experiment, was turned over to me at end of September, 1904. Water, often visibly fouled with sewage, was collected for me from the immediate neighbourhood of H.M.S. "Egmont," the stationary depôt ship at Malta which has living on board a number of men varying from 400 to 700. Three bottles full totalling 1,800 c.c. were taken and their contents passed through a Berkefeld filter which had been ascertained by previous experiment* not to pass *Micrococcus melitensis*. The deposit on the filter candle was then washed by passing 600 c.c. of distilled water through, and then with a sterile swab the deposit was emulsified in 10 c.c. of this and with a sterile syringe injected subcutaneously between the shoulders of Monkey No. 71. This I repeated three times a week from September 29 to November 9, by which time the equivalent of 37·8 litres of sewage fouled sea water had been administered. By now this monkey had become very thin and wasted, on November 11 it was decidedly ill and died on the 12th. The usual *post-mortem* inoculations of tubes and plates from viscera, etc., were made, but no *Micrococcus melitensis* was recovered. The temperature and blood had been under continuous observation, but there was never any fever or agglutination reaction.

Result.—Negative. Monkey No. 71 was not infected.

VII. Feeding Experiments.

(a) *Monkeys Fed with Boiled Potatoes Contaminated with Mediterranean Fever Urine naturally containing Living* Micrococcus melitensis.

The urine used was obtained from my Ambulatory Cases IX and XI, and it was demonstrated by plating twice weekly from August, 1905, to

* See p. 108, Part I of these Reports.

April, 1906, to have contained living *Micrococcus melitensis* during the whole period of these experiments. Each monkey was given once a day half a potato on which had been spread about a teaspoonful of infected urine; they invariably ate the whole or a portion of this.

Monkey No. 120 was received from Calcutta on July 28, 1905, was fitted with a leather-covered collar and chain, as were all the monkeys in these feeding experiments, so as to avoid abrasions of the mouth, and their food was invariably soft. After the customary preliminary observations, potatoes, prepared as above, were given to it daily for a period of 29 days commencing on August 7. The animal died on September 26. In my absence Captain Kennedy kindly made the usual *post-mortem* inoculations of tubes and plates from the organs; no *Micrococcus melitensis* was recovered. The animal's temperature had been under observation twice daily and blood twice weekly. There was never any wave of fever or any agglutination reaction.

Monkey No. 120 was not infected.

Monkey No. 121.—Similarly experimented with.

August 7 till September 5, 1905, fed daily with urine-contaminated potatoes.

September 6 till March 11, 1906, fed every Tuesday and Friday without intermission with *Micrococcus melitensis*-containing-urine-contaminated potatoes. This animal had been under close observation the whole period, it had had no wave of fever nor had its blood ever reacted.

Monkey No. 121 had not been infected.

Monkey No. 26 (New Series) was similarly experimented with, commencing October 29, 1905, and continuing twice weekly till March 11, 1906, when the experiment was suspended. This animal similarly had resisted infection thus sought to be conveyed.

(b) *Monkeys Fed with Potatoes Soiled with Dust which had been Saturated with Mediterranean Fever Urine naturally containing* Micrococcus melitensis.

The urine used was from the same patients as in the preceding experiments, and was yielding 200 to 8,000 colonies of *Micrococcus melitensis* per cubic centimetre. The dust was first sterilised, then a teaspoonful, placed in a watch glass, was saturated with a teaspoonful of the urine and left to dry at room temperature for 24 hours; then about half a gramme of it was ground up with half a boiled potato and given to each monkey.

Monkey No. 122.—After the usual preliminary observations feeding was commenced as described on August 7, 1905, and was continued daily for 28 days. From September 6 to February 25, 1906, it was continued twice weekly with an intermission of one week in November and another in December because of diarrhœa, and on March 2, 1906,

the animal died. There had never been any wave of temperature, a very slight agglutination reaction had been noticed on October 4, 1905, then disappearing to appear once again on December 26, and this only in the low dilution of 1 in 30. The usual *post-mortem* inoculations of tubes and plates were made and, much to my surprise, seven colonies of *Micrococcus melitensis* were recovered and verified in a plate prepared from the left kidney; there were none from the other organs or lymphatic glands.

Monkey No. 122 had been infected.

Monkey No. 123.—After the usual preliminary observations to prove freedom from infection, similar feeding was commenced with this animal also on August 7, 1905, and continued daily for 28 days. From September 6 to October 25 it was fed with the Mediterranean Fever urine-dust-contaminated potato twice weekly. On October 21 the agglutination reaction was obtained in a dilution of 1 in 30, rising to 1 in 320 October 25. Blood was taken from the external saphenous vein and incubated in broth, but *Micrococcus melitensis* was not obtained. On October 29 the agglutination reaction was up to 1 in 1500, on the evening of which day its temperature was 103°; there had been no previous indication of a wave of fever, and as next day the temperature was down to 101°·8, fearing I was in danger of missing the irrefutable proof of recovery of *Micrococcus melitensis* from this animal, I administered chloroform, and made the usual inoculations from glands and organs, and after the usual period of incubation thus recovered and verified *Micrococcus melitensis* in numerous colonies from the lymphatic glands and liver, kidney and spleen.

Monkey No. 123 had been infected.

Monkey No. 30.—Feeding was commenced with this monkey on October 31, 1905. Sufficient infected urine-dust was prepared every Tuesday and Friday to allow of giving this monkey a daily portion ground up with potato, and this was continued till December 24; it was suspended from 25th to 29th because of an attack of diarrhœa which the monkey developed; resumed again December 30 till January 7, 1906, when it was again suspended for the same reason. In spite of treatment the monkey got worse and died January 10. The usual *post-mortem* inoculations of tubes and plates were made, but *Micrococcus melitensis* was not recovered. This monkey had never developed any wave of fever or any agglutination reaction.

Monkey No. 30 had not been infected.

(c) *Monkeys Fed with Potatoes Soiled with an Emulsion of* Micrococcus melitensis *Derived from a Human Spleen Culture.*

A five-day growth of *Micrococcus melitensis*, fifth generation from human spleen, the product of one straight stroke of an infected needle on an agar slope was taken daily, and emulsified in water; a boiled

potato was cut in two, each cut surface was soiled with the emulsion, and the two halves were then given to the two monkeys, Nos. 124 and 125. This was done daily for 29 days, commencing (after the usual preliminary observations) on August 7, 1905. It must be noticed that here one was dealing with enormous numbers of the cocci each time, but at that period it was deemed of considerable importance to determine absolutely whether or not monkeys could be infected by the alimentary canal.

Monkey No. 124.—Feeding commenced August 7. Agglutination reaction first obtained on August 20 in a dilution of 1 in 30, rising to 1 in 320 on August 24, and 1 in 1000 on August 27. There was no very distinct wave of fever, but 103°·2 was recorded on August 20, 104° on the 24th, and 105° on August 28; prior to August 20 the animal's temperature was ranging between 101° and 102°·6. Blood was taken and incubated in broth on August 21, and again on August 29 and September 19. *Micrococcus melitensis* was not recovered from the blood on any of these occasions, so fearing to lose the indubitable proof of actual recovery of the micro-organism, I gave the animal chloroform on October 1, and made the usual *post-mortem* inoculations of plates and tubes. *Micrococcus melitensis* was thus recovered and verified, but only in small quantity :—

7 colonies	from	the right axillary	lymphatic	glands	
2	„	„	left	„	„	„
1 colony		„	right femoral	„	„

and none from the large viscera or other lymphatic glands.

Monkey No. 125.—Feeding commenced August 7. Agglutination first obtained September 4 in a dilution of 1 in 40, rising to 1 in 500 on September 10, and 1 in 800 on September 28. There was a slight wave of temperature commencing August 25, when it rose to 103°·2, being 104° on the 26th, and remaining at or about this for nine days, when it came down to what it had been before, 101° to 102°·5. Blood was taken and incubated on September 19, but no *Micrococcus melitensis* was recovered, and in consequence chloroform was given on October 2, and the usual *post-mortem* inoculations of slopes and plates made. Here, as in the preceding case, *Micrococcus melitensis* was recovered and verified, but only in small quantity, and only from the lymphatic glands: right femoral 2 colonies, right axillary 1 colony.

Monkeys Nos. 124 and 125 were both infected.

(d) *Monkeys Fed with Potatoes Soiled with Emulsion of* Micrococcus melitensis *Derived from Human Urine.*

This experiment was precisely a repetition of the last, and was carried out in an exactly similar fashion, the only difference being that

a different strain of *Micrococcus melitensis* was used, one derived from the urine of Ambulatory Case No. IX.

Monkey No. 126.—Feeding commenced August 7. Agglutination first appeared on August 24, very slight in a dilution of 1 in 30; it was still 1 in 30, very faint, on August 27, nil on September 1, and 1 in 80 on September 4 and 10. There was no distinct wave of fever, the highest temperatures recorded being 103° on August 28, and 103°·4 on August 29. The animal died on September 14. In my absence the usual inoculations of plates and tubes were made by Captain Kennedy, but no *Micrococcus melitensis* was recovered.

Monkey No. 127.—Feeding commenced as above on August 7, and continued for 29 days. Agglutination first appeared on September 4, being 1 in 120, rising to 1 in 300 on September 6, 1 in 500 on September 10, and 1 in 800 on September 28. The first rise of temperature was on August 23 to 103°·6, and remained between 102°·8 and 104° till September 29. Blood was taken from it on September 14 and incubated in broth, but *Micrococcus melitensis* was not recovered from this, and in consequence I administered chloroform on October 3, and made the usual inoculations of plates and tubes. *Micrococcus melitensis* was thus recovered and verified, but only from the lymphatic glands as follows, none being recovered from the liver, kidneys, or spleen:—

	Micrococcus melitensis colonies.
Left axillary lymphatic glands	103
Right ,, ,,	19
Left femoral ,,	21
Right ,, ,,	4
Cœcal mesenteric ,,	3

Monkey No. 126 infection doubtful.
Monkey No. 127 infection proved.

Result.

(*a*) Of three monkeys, Nos. 120, 121, and 26, fed with potato soiled with fresh naturally-infected urine, none became infected.

(*b*) Of three monkeys, Nos. 122, 123, and 30, fed with potatoes soiled with dried dust which had been contaminated with naturally-infected urine, two, Nos. 122 and 123, became infected, No. 30 did not.

(*c*) Of two monkeys, Nos. 124 and 125, fed with potatoes soiled with pure spleen cultures of *Micrococcus melitensis*, both became infected.

(*d*) Of two monkeys fed with potatoes soiled with pure cultures of *Micrococcus melitensis* derived from naturally-infected urine, one, No. 127, became infected, the other, No. 126, doubtful.

The exact incubation period in these food-infected monkeys is not determinable, owing to the impossibility of saying on which particular day infection was received, but that it is very variable is indicated by the varying period from the commencement of the series of feedings to the date of appearance of the agglutination reaction, as follows:—

Serial number of monkey.	Source of *Micrococcus melitensis* infecting the food.	Number of days between commencement of feeding and appearance of agglutination reaction.	Date of commencing feeding.
122	Urine dust	58	August 7, 1905
123	Urine dust	75	August 7, 1905
124	Spleen culture	13	August 7, 1905
125	Spleen culture	28	August 7, 1905
127	Urine culture	28	August 7, 1905

Why fresh naturally-infected urine should have failed to infect, and the same urine dried in dust have succeeded in infecting twice out of three times, is somewhat puzzling to understand, unless in some way, such as by causing minute scratches of the mucous membrane, the dust facilitated the entrance of the micro-organism into the system.

VIII. To Estimate Relative Virulence of Mediterranean Fever Spleen Pulp Direct from Human *Post-mortem* Case.

(Experiment 30, suggested by Sub-Committee.)

Monkey No. 87, after usual preliminary observations, was used for this experiment, and on May 31, 1906, received subcutaneously an injection of about half a gramme of such a spleen emulsified in sterile salt solution. *Micrococcus melitensis* was recovered and verified from this spleen on June 5. Monkey No. 87, up to June 30, 1905, had developed no fever or agglutination reaction. According to previous experience of subcutaneous inoculation of monkeys, when the incubation period is usually three to six days, this meant failure of infection, either due to absence of *Micrococcus melitensis* from the small portion of spleen used, or due to the monkey's powers of resistance. It was decided to try again. On June 30, therefore, another such injection was given to the same monkey, the spleen of this case being also subsequently proved to contain *Micrococcus melitensis.* The agglutination reaction first appeared on July 6, in a dilution of 1 in 80, rising to 1 in 200 on July 16. There was no distinct wave of fever, probably due to the fact that from July 2 to the date of its death the animal suffered severely from diarrhœa, which was absolutely resistant to treatment. The usual *post-mortem* inoculations were made, and

Micrococcus melitensis was recovered (and verified) in profusion from the spleen and mesenteric glands, but not from the bile, liver, or kidneys.

Result.—Monkey 87 was infected with a result somewhat indeterminate as to virulence of such spleen pulp, though the inference would be that it was obviously not great, or the first effort would not have failed, and in the second the micro-organism would certainly have invaded the liver and kidneys as well as the spleen.

IX. To Determine Infectivity of Urine from Ambulatory Cases of Malta Fever.

It was felt to be important to have definite information on this point; and to ensure that such urine did get into the system of the monkey experimented on, I determined to inject it subcutaneously. Accordingly, after the usual preliminary observations, Monkey No. 105 was on July 17 injected between the shoulders with 8 c.c. of fresh urine from Ambulatory Case No. IX (B. Worley, No. 1657). This injection was repeated on the 18th and 19th; a specimen of the urine used was plated each time and subsequently proved to contain living *Micrococcus melitensis.* The animal's blood was examined for agglutination reaction twice daily, and it first appeared on July 31 in a dilution of 1 in 20, rising to 1 in 160 on August 3, 1 in 500 on August 6, and 1 in 1000 on August 10. It commenced a wave of fever on July 31, when its temperature was up to 104°, being 105° on August 5, and running down to nearly normal on August 8. Blood was aseptically taken from the saphenous vein on August 11, and incubated in broth. *Micrococcus melitensis* was thus recovered and verified. From August 3 till its death on September 7, it suffered intermittently from diarrhœa. The urine, which had been injected under the skin of the back between the shoulders, was absorbed, and there was never any abscess formation, or other appearances usual with subcutaneous urine extravasation in the human subject. In my absence, Captain Kennedy kindly made the usual *post-mortem* inoculations of plates and tubes, and *Micrococcus melitensis* was recovered from spleen, liver, and lymphatic glands, not from the kidney or heart's blood.

Result.—The urine of this ambulatory case of fever was thus proved to be infectious.

X. Subcutaneous Inoculation of Monkeys with Pure Cultures of Living *Micrococcus melitensis.*

(Experiments 26, 27, 28, suggested by Sub-Committee.)

This has now been done comparatively frequently, and as the results of this procedure closely resemble each other in each individual

case, a sufficient number of which have already been reported in detail in former volumes of these Reports, I do not propose to do more than refer collectively to my own cases. Suffice it to say, that this procedure invariably results in a very few days in a typical attack of fever, with development of an ultimately high agglutination reaction, presence of *Micrococcus melitensis* in the peripheral blood, etc. The most interesting feature is the comparatively short incubation period as calculated from date of infection to commencement of wave of temperature ; this is shown in the accompanying table :—

Serial number of monkey.	Date of inoculation.	Date of appearance of agglutination.	Date of commencing wave of fever.	Incubation period.
78	October 15, 1905	October 21, $\frac{1}{30}$	October 18, 105°	3
79	May 15, 1905	May 22, $\frac{1}{1000}$	May 20, 104°·4	5
80	May 15, 1905	May 22, $\frac{1}{1500}$	May 19, 105°	4
27	October 25, 1905	November 1, $\frac{1}{30}$	November 1, 103°·4	7
37	February 3, 1906	February 9, $\frac{1}{30}$	February 6, 105°	3
38	February 3, 1906	February 7, $\frac{1}{30}$	February 5, 105°	2

It has been usual to examine experimental monkeys for agglutination reaction twice a week, and it is to be presumed, though it was not observed, that this reaction was present in Monkeys Nos. 79 and 80 after May 19, when it was absent, but before May 22 when it was so high.

Remarks.

A consideration of the foregoing experiments leads to the conviction that the monkey, though less tolerant of infection by *Micrococcus melitensis* than any other laboratory animal, reacting for instance with a far more marked wave of fever than the goat, is not an easy animal to infect unless given *Micrococcus melitensis* pure and in relatively large amount. Thus in the dust experiments the two monkeys, Nos. 48 and 64, which took infected dust into their noses by their own inspiration efforts, remained uninfected, while of three monkeys in which it was puffed up their nostrils, two, Nos. 65 and 103, became infected. In the first case the monkeys were noticed to be breathing as quietly as possible, and inspiring as little infected dust as they were able; in the second it was puffed well back into the nasal cavity and was afterwards noticed at the back of the pharynx; this was looked for in Monkeys 48 and 64, but apparently they never took it in in sufficient quantity for it to be thus visible. Of the 10 monkeys used for feeding experiments, four were receiving *Micrococcus melitensis* in very large quantity and in pure culture, and of these, three, Nos. 124, 125, and 127, became

infected. The other six were receiving *Micrococcus melitensis* in much smaller quantity and in association with other micro-organisms contained in urine, and of these only two, Nos. 122 and 123, became infected. Man, judging from the few cases of accidental experimental infection which have been published, is much more susceptible. Variation of susceptibility in different monkeys is also shown by the many groups in which, such as Section I. (c), identical procedure has resulted in the infection of some monkeys and not of others.

An interesting feature, which is brought out by a comparison of the incubation periods of the monkeys which had been infected by a pure emulsion of *Micrococcus melitensis*, is the difference in period according as the inoculation was a subcutaneous injection or absorption through an unbroken mucous membrane, it being decidedly shorter in the first than in the second group (reckoned to day of commencement of wave of fever), as shown in the following table:—

Subcutaneous inoculation.		Inoculation through unbroken mucous membrane.		
Serial number of monkey.	Incubation period.	Serial number of monkey.	Mucous membrane of—	Incubation period.
78	3	61A	Conjunctiva	15
79	5	100	Conjunctiva	14
80	4	48	Trachea	15
27	5	118	Nose	14
37	3			
38	2			

To sum up the foregoing experiments—

Dust Infected with Pure Culture of Micrococcus melitensis.—Nine monkeys experimented on. Five remained uninfected, four became infected—two through the eyes and two through the nose.

Dust infected with urine naturally containing Micrococcus melitensis.—Four monkeys experimented on; none became infected.

Contact Infection.—Two uninfected monkeys placed in *limited* contact with infected monkeys. Neither became infected. Infection by skin and skin parasites failed.

Two uninfected monkeys placed in *unlimited* contact with infected monkeys. One became infected, presumably through urine of infected animals, the other remained uninfected.

Infection through various unbroken mucous membranes with emulsion of Micrococcus melitensis.—All monkeys experimented on through conjunctival, tracheal, and nasal mucous membranes became infected.

Infection by Mosquitoes.—The monkey bitten every other day by

presumably infected mosquitoes for a period of two months did not become infected.

Infection by Food.—Three out of four monkeys given food contaminated by pure culture of *Micrococcus melitensis* became infected. Two out of six monkeys given food contaminated with urine from cases of Mediterranean Fever naturally containing *Micrococcus melitensis* became infected when dust was used as a vehicle.

Spleen pulp direct from a fatal case of Mediterranean Fever in man is not excessively virulent.

Subcutaneous infection by injection with hypodermic syringe of emulsion of pure culture of *Micrococcus melitensis* constantly produces infection with a very short incubation period. Urine from Mediterranean Fever cases naturally containing *Micrococcus melitensis* produces infection when injected subcutaneously into a monkey. Presumably, then, such urine could infect anyone engaged in nursing or who otherwise came in contact with it, through any existing scratch or abrasion of the cuticle.

Conclusions.

(1) The possibility of infection through the eyes and nose by means of highly infected dust has been experimentally demonstrated.

(2) The possibility of infection by unlimited contact has been experimentally demonstrated.

(3) The possibility of infection through food contaminated (*a*) with pure cultures of *Micrococcus melitensis*, (*b*) with dust soiled with urine naturally containing *Micrococcus melitensis*, has been experimentally demonstrated.

(4) The possibility of infection by urine of patients, through skin scratches, wounds, and abrasions, has been experimentally demonstrated.

II. IMMUNITY, SERUM, TOXIN, AND VACCINE EXPERIMENTS ON MONKEYS WITH REGARD TO MEDITERRANEAN FEVER.

By Staff-Surgeon E. A. Shaw, R.N.

Immunity.

The question as to whether an attack of Mediterranean Fever confers any protection against a subsequent exposure to infection is a very important one, and I determined to examine it—at any rate in monkeys—experimentally. As it was essential to have absolute proof of the first infection, a method had to be devised of securing this without sacrificing the monkey intended to be later subjected to a further infection. To recover *Micrococcus melitensis* from the blood of the experimental animal during life seemed the simplest way of doing this. The method described by Dr. Zammit* of doing this had not in my hands given satisfactory results. This I put down to two things, the small quantity of blood obtained by it and the risk of the blood taking up some disinfectant from the chemically-disinfected surface of the ear from which it was collected.

After carefully examining several monkeys, I considered it would be feasible to obtain blood to the amount of several cubic centimetres from a fairly large vein I found running superficially along the back of the calf muscles, more or less comparable to the external saphenous vein in the human subject. An attempt was first made to tap this with a small serum syringe, but this, the needle being too large relatively to the vein, was not successful. A sterile glass pipette was then taken with a constriction separating a containing bulb from the large open end, which was lightly plugged with cotton wool and fitted with a rubber tube, terminating at its free extremity in a glass tube mouthpiece. The capillary end of the pipette was drawn out fine in the peep light of a Bunsen burner, and the fine hair-like tube thus made broken through so as to give a fine terminal extremity of about a $\frac{1}{4}$ of an inch long. The skin just over the vein was drawn sideways and punctured with a sterile needle, and then allowed to resume its original position, so that the puncture came just over the vein; the mouthpiece of the rubber tube having been placed in one's mouth, the fine terminal end of the associated pipette was pushed obliquely into the vein through the small skin puncture previously made. When the point of the pipette was actually in the vein, blood immediately made its appearance in the capillary portion of the pipette, and it was found possible by gentle aspiration to get from 2 to 3 c.c. of blood into the containing chamber, whence it could be tranferred to broth tubes,

* Vol. 1, p. 89 of these Reports.

incubated and then subcultured on to agar slopes. In doing this on the infected monkey, the hair was cut close to the skin with scissors for about an inch square in the desired situation, then a pad dipped in a solution of lysol was applied to this area for $1\frac{1}{2}$ hours, then removed, and the skin allowed to dry, a rough tourniquet lightly applied at the knee; and when the vein was distended it was tapped as described.

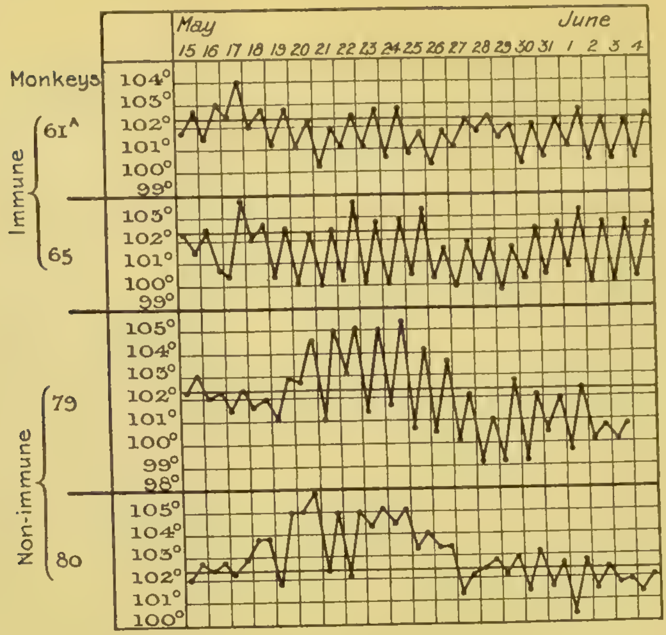
This procedure was first applied by me to an infected monkey (No. 72) on October 10, 1904, and *Micrococcus melitensis* was recovered from the blood thus obtained. I and other members of the Commission to whom I demonstrated it have since applied this method successfully to many other infected monkeys. The most favourable period at which to make use of it on an infected monkey would appear to be in the early stage of the fever, directly after the agglutination reaction has appeared, and when the top of the usual wave of fever has just been reached.

I expected in this way to have quite a number of monkeys on which to determine if one attack of fever conferred any protection against a second infection. But these monkeys, under the conditions of captivity which we were compelled to adopt, are not long lived, and most of them died at varying periods of from one to three months after the primary infection. This does not appear to have been necessarily secondary to their infection; the same mortality prevailed among the unused monkeys, from which subjects for experimentation were taken as required.

Experiment I.—In May, 1905, I had at my disposal Monkey No. 61A, which on December 19, 1904, had been infected with *Micrococcus melitensis* through the conjunctival mucous membrane, and from whose peripheral blood, taken on January 14, 1905, this micro-organism had been recovered; and also Monkey No. 65, which on January 25 had been dust-infected by the nose, and from whose blood, taken on February 14, *Micrococcus melitensis* had been recovered. Two unused monkeys, Nos. 79 and 80, had also been under preliminary observation in order to serve as controls.

May 15.—A three-day growth of a single stroke inoculation on agar of third generation of *Micrococcus melitensis* from human spleen was emulsified in 5 c.c. of sterile normal salt solution, and each of these four monkeys received 1 c.c. of this subcutaneously between the shoulders. I append a comparative chart showing for 21 days, starting from the date of injection (May 15), the curves of temperature of each of these four monkeys, with the usual base line ruled in at 102°·4.* There was no further rise in any of them after last date charted. The uninfected monkeys, Nos. 79 and 80, show a marked wave of fever commencing between the fourth and fifth day after the subcutaneous

* See charts in Part I of these Reports.



injection of *Micrococcus melitensis.* The presumably recovered monkeys, 61A and 65, show no such disturbance. Monkey No. 79 died on June 4, and *Micrococcus melitensis* was recovered from its organs *post-mortem*, thus demonstrating the activity of the strain of *Micrococcus melitensis* used.

The agglutinations were as follows :—

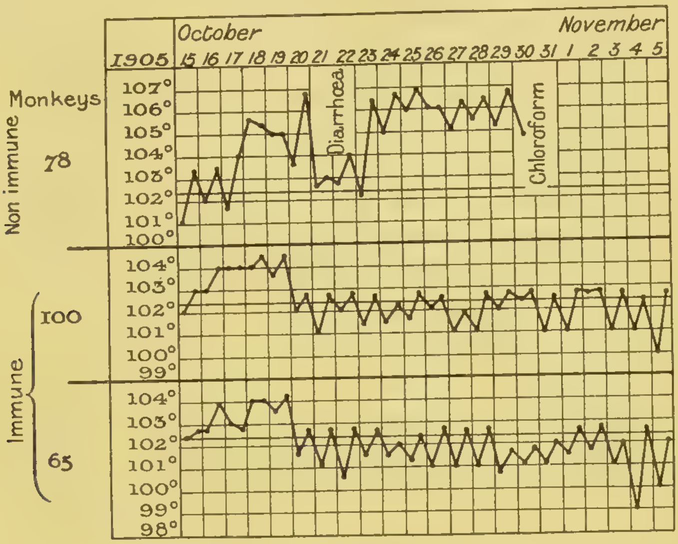
Date.	Monkey No. 61A.	Monkey No. 65.	Monkey No. 79.	Monkey No. 80.
April 25	1 in 500	1 in 250	Nil	Nil
May 15	1 in 500	1 in 200	Nil	Nil
May 22	1 in 1000	1 in 800	1 in 1000	1 in 1500
May 29	1 in 1000	1 in 600	1 in 800	1 in 3000
June 5	1 in 1000	1 in 800	Dead	1 in 2500
June 12	1 in 800	1 in 400	—	1 in 2500
June 18	1 in 1800	1 in 500	—	1 in 3000
June 25	1 in 800	1 in 400	—	1 in 2000
July 2	1 in 1000	1 in 1000	—	1 in 3000

Showing an increased agglutination in 61A and 65 following the subcutaneous injection, but a much greater response in this direction on the part of one of the previously uninfected monkeys (80). Blood was taken from three of these monkeys, 61A, 65, and 80 (79 was dead) on June 25 in the manner described, and incubated in broth; that from 61A and 65 did not yield *Micrococcus melitensis*, that from 80 did. This was repeated with Monkeys Nos. 65 and 80 on July 11 (61A was

suffering from bad diarrhœa), and again *Micrococcus melitensis* was recovered from 80 but not from 65.

Experiment II.—In October, 1905, I had available for repetition of the foregoing experiment Monkey No. 100, which had been infected during the preceding June through the conjunctiva and from whose peripheral blood *Micrococcus melitensis* had been recovered; and also Monkey No. 65, the same previously-infected monkey mentioned in the last experiment; Monkey No. 78, which had been under observation since the preceding May, and had never had the fever, was taken as a control.

October 15.—Each of these three monkeys received subcutaneously between the shoulders 1 c.c. of an emulsion of a five-day third generation growth of *Micrococcus melitensis* isolated from the human



spleen. The accompanying chart shows the temperature curves of all three starting from the date of the subcutaneous injection of *Micrococcus melitensis.* The very marked wave of fever in No. 78 contrasts conspicuously with the comparatively slight disturbance in Monkeys Nos. 100 and 65, the temperatures of which never rose after the last date charted.

The drop in the fever on October 21 and 22 in the case of Monkey No. 78 may possibly have been due to a sharp attack of diarrhœa which it developed at that time.

As I wished to cut and stain sections of infected organs, and as by October 30 there was every reason to think that the system of Monkey No. 78 was saturated with *Micrococcus melitensis*, it was on this date chloroformed, and the usual *post-mortem* inoculations were made; later, *Micrococcus melitensis* was recovered and verified in greatest profusion from its viscera, lymphatic, and salivary glands.

The agglutination reactions were as follows:—

Date.	Monkey No. 78.	Monkey No. 100.	Monkey No. 65.
October 15	Nil	1 in 800	1 in 40
October 18	Nil	1 in 800	1 in 40
October 21	1 in 30	—	—
October 22	1 in 320	1 in 800	1 in 40
October 25	1 in 1500	—	—
October 29	1 in 3000	1 in 1500	1 in 40
November 5	Dead	1 in 1500	1 in 40
November 12	—	1 in 1500	1 in 40

Showing much the same features as in the preceding experiment.

Though the resistance on the part of the immune Monkeys Nos. 61A, 65, and 100, does not appear to have been absolute, as in each there was a slight disturbance of temperature following the injection of *Micrococcus melitensis*, it must be remembered that in these experiments enormous numbers of *Micrococcus melitensis* were injected, an artificial infection being induced to a degree out of all proportion to one in the least likely to be met with in Nature. Also it has been shown in other microbic diseases in animals that immunity due to a previous attack can be overcome if a sufficient quantity of the responsible micro-organism be injected.

Conclusion.—Monkeys which had previously had an attack of Mediterranean Fever react much less markedly than others which have not to the same dose of living *Micrococcus melitensis*; *ergo*, a previous attack confers some protection against a subsequent exposure to infection.

A Therapeutic Serum.

Having two goats available which had been frequently subjected by me to subcutaneous injections of *Micrococcus melitensis* in large quantity, and whose blood gave a constantly high agglutination reaction, I determined to ascertain if the serum of one of these would have any effect on the course of the fever experimentally induced in a monkey. The goat selected to supply serum was the one with the higher agglutination, 1 in 3000; it has been already mentioned as the "white kid" in experiments described by me in Vol. 4 of these Reports, but at this period was mature.

On February 4, 1906, this goat's serum agglutinated 1 in 3000. Its last previous injection of *Micrococcus melitensis* had been given two months prior to this. On February 7 the goat's neck was shaved and sterilised over a selected area, and 5 c.c. of blood, taken from its right external jugular vein with a sterile serum syringe, were put in a flask with 80 c.c. of broth, and incubated. *Micrococcus melitensis* was

subsequently recovered and verified from this. Secondly, about half a litre of blood was run off from the same vein at the same time into a previously prepared sterilised conical filtration flask provided with a side tube, the nozzle of the serum syringe being replaced in the needle with a sterilised metal nozzle which had been fitted to a rubber tube connected with a glass tube which ran through an indiarubber cork in the neck of the flask to very near its bottom. The desired quantity of blood having been obtained, a spring clamp was applied to the rubber tube, the apparatus removed and placed in a dark cupboard. Next day the resulting serum was decanted through the side tube into a small conical sterilised flask. At the same time some of it was removed with a sterile pipette, and 1 c.c. was distributed over six agar plates, which were incubated at 37° C., and gave no growth of any kind after six days' incubation. This would indicate that *Micrococcus melitensis* in the circulating blood is contained in the corpuscles rather than in the fluid portion of the blood.

In readiness for the experiment two monkeys, Nos. 37 and 38, had been kept under preliminary observation for a week.

On *February* 3, 1906, each monkey received simultaneously between the shoulders and on the right side an injection of 1 c.c. of an emulsion of *Micrococcus melitensis* (first generation, fifth day growth from human spleen—Dakin), representing 1/6 of a single stroke inoculation of an agar slope.

February 9.—On this date the fever was well established in both monkeys, but rather more markedly in 37 than in 38; the former was therefore selected to receive hypodermically 3 c.c. of the serum obtained from the white goat as already described, the latter remaining untreated to afford a comparison.

February 10.—Monkey No. 37 received another hypodermic injection of the same goat's serum, this time of 5 c.c.

February 11	Agglutination	was, in	Monkey 37, 1 in 160.
February 11	„	„	Monkey 38, 1 in 600.
February 18	„	„	Monkey 37, 1 in 500.
February 18	„	„	Monkey 38, 1 in 1500.
February 25	„	„	Monkey 37, 1 in 500.

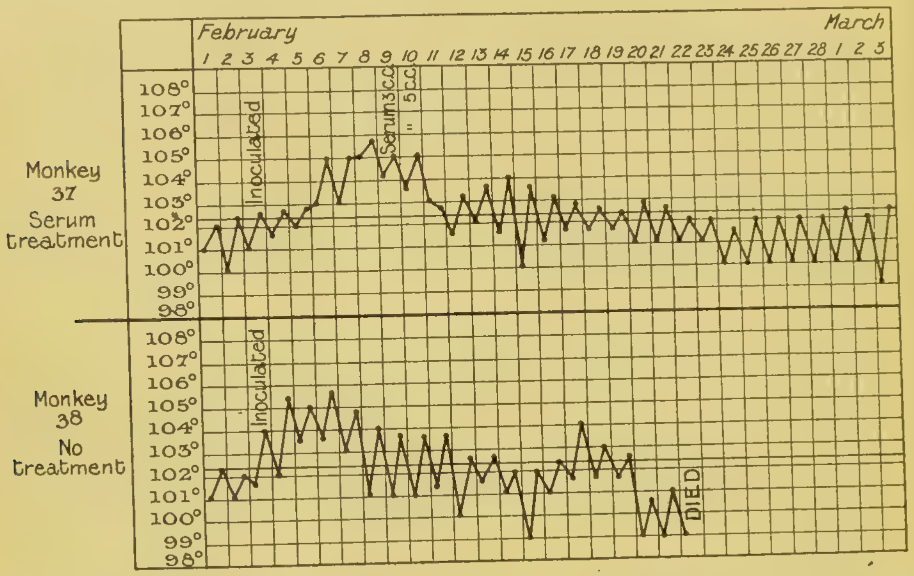
February 22	Monkey 38 died.
March 9	Monkey 37 died.

In both animals the usual *post-mortem* inoculations of slopes and plates were made, and as *Micrococcus melitensis* had not been previously recovered from the brain of monkeys, four plates were prepared from a similar amount of brain substance in each taken from the right parietal convolutions. In each case there was an abundant recovery of *Micrococcus melitensis* from the spleen and lymphatic glands, a less

plentiful recovery from the liver, and a still more restricted recovery from the kidneys; but there was no appreciable difference in number of colonies of *Micrococcus melitensis* in the two cases.

Micrococcus melitensis was recovered from the brain of both, 12 colonies in the case of Monkey No. 37 and 5 colonies in Monkey No. 38.

I append charts showing the course of temperature and dates of injections in each.



Result.—It will be seen that there is no such difference between the clinical features of these two cases of Mediterranean Fever in monkeys as to encourage a strong belief in the future successful development of a therapeutic serum.

Toxins.

To determine whether toxins of *Micrococcus melitensis* produce on monkeys the same clinical phenomena as living cultures.

Experiment I.—A flask containing 100 c.c. of nutrient broth was inoculated with a culture of *Micrococcus melitensis* derived from a Mediterranean Fever patient's blood; this was incubated for 21 days, then passed through a sterilised Chamberland F candle into a sterilised flask. Agar slopes were inoculated with the filtrate and incubated at 37° C. for four days; there was no growth of any description on these.

Two monkeys, Nos. 58 and 59, which had been under previous observations to determine freedom from infection, then received peritoneal injections with a serum syringe of the above filtrate as follows, No. 59, the somewhat larger animal, receiving a rather larger dose than the other:—

Date.	Monkey No. 58.	Monkey No. 59.
1904—		
August 8	5 c.c. of filtered toxins	7 c.c. of filtered toxins
August 9	Diarrhœa. Nil	7½ ,, ,, ,,
August 10	Diarrhœa better. Nil	6 ,, ,, ,,
August 11	5 c.c. of filtered toxins	6½ ,, ,, ,,
August 12	6 ,, ,, ,,	7 ,, ,, ,,
August 13	5 ,, ,, ,,	6 ,, ,, ,,
August 14	5 ,, ,, ,,	6 ,, ,, ,,

This procedure was followed by a slight rise of temperature, which began the day after the first injection in each case and lasted until the third day after the injections ceased in the case of No. 59, and until the fourth day in the case of No. 58, after which it dropped. This rise varied from day to day from 1° to 1°·5 F.

The agglutination reaction first appeared in No. 58 in a dilution of 1 in 20 on August 19, and was 1 in 20 August 24, 1 in 40 August 30, 1 in 80 September 5, remaining at this until the last time it was taken, September 29. The animal was chloroformed on October 2 and the usual *post-mortem* inoculations were made. No *Micrococcus melitensis* was recovered. In Monkey No. 59 the agglutination reaction first appeared August 24 in a dilution of 1 in 20, was 1 in 20 August 30, and 1 in 80 September 5. The animal was chloroformed on September 11 and the usual *post-mortem* inoculations were made. *Micrococcus melitensis* was not recovered.

Experiment II.—In this case it was decided to use broth cultures of *Micrococcus melitensis* killed by a heat of 60° C., instead of eliminating the micro-organism by filtration.

On July 22, 1905, a 60-c.c. broth flask was inoculated with *Micrococcus melitensis* recovered from an infected monkey; this was incubated at 37° C. till July 29, when a sub-culture (A) on to three agar slopes was made, the flask was then heated in a water-bath to 60° C., at which temperature it was kept for 30 minutes; then a sub-culture (B) was made also on three agar slopes. On August 1 the sub-culture A showed a plentiful growth of pure *Micrococcus melitensis*; the sub-cultures B were sterile.

Two monkeys, Nos. 116 and 117, which had been under preliminary observation, were subjected subcutaneously between the shoulders with this dead broth culture of *Micrococcus melitensis*, each receiving 5 c.c. on August 1 and 10 c.c. on August 19.

The agglutination reaction first appeared in Monkey No. 117 on August 6 in a dilution of 1 in 30, being 1 in 160 on August 9, 1 in 160 on August 13; highest, 1 in 400, on August 27; then falling away to 1 in 100 on September 10 and 1 in 40 on October 29. On August 13

blood was taken from the external saphenous vein and incubated in broth. No *Micrococcus melitensis* was recovered from this.

The agglutination reaction appeared in No. 116 on August 9 in a dilution of 1 in 30, which was never exceeded. The reaction was last found on September 6, and never appeared again, though examined for twice weekly till October 4, and thereafter once weekly till October 29. Blood was taken from the external saphenous vein and incubated in broth on August 17. *Micrococcus melitensis* was not recovered from this.

The course of the temperature in both these monkeys was precisely similar to that in the preceding experiment. There was a slight rise of temperature following each injection, but no wave of fever.

Experiment III (a).—Thinking that possibly there might be some difference between the results obtained by using dead broth cultures of *Micrococcus melitensis* as compared with those obtained by using dead agar slope cultures, I decided to repeat the experiment with the latter.

Accordingly, one agar slope of a six-day growth of *Micrococcus melitensis*, third generation, derived from human spleen, was emulsified in sterile normal salt solution and killed by heating in a water bath to 70° C. for an hour. I may mention here that this strain of *Micrococcus melitensis* so treated survived heating for half-an-hour to 65° C. This dead emulsion was taken up in a serum syringe and injected subcutaneously between the shoulders of two normal monkeys, Nos. 31 and 32, on November 4, 1905, each receiving half, that is the equivalent of half the product of one agar slope.

In both monkeys the agglutination reaction was first obtained on November 9.

Date.	Monkey No. 31.	Monkey No. 32.
November 9	1 in 30	1 in 30
November 12	1 in 150	1 in 100
November 19	1 in 250	1 in 400
November 26	1 in 250	1 in 400

In both there was a trifling elevation of temperature, but no wave of fever.

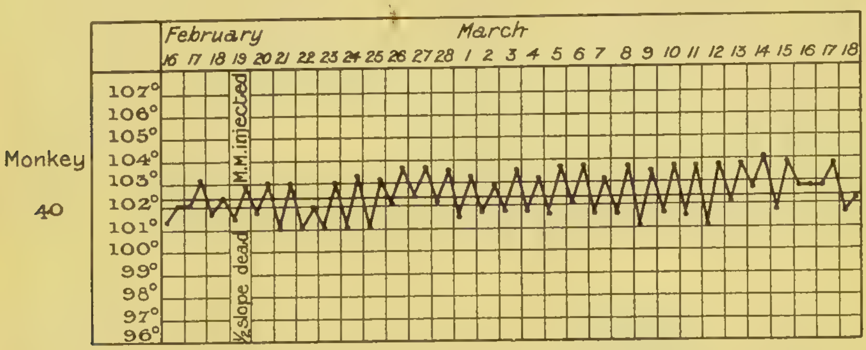
Experiment III. (b).—The foregoing procedure was repeated on two other normal monkeys, Nos. 39 and 40, using one agar slope of a four-day growth of *Micrococcus melitensis*, second generation, derived from human spleen, on February 19, 1906.

In both monkeys the agglutination reaction was first obtained on February 25, as follows :—

Date.	Monkey No. 39.	Monkey No. 40.
February 25	1 in 30	1 in 50
March 4	1 in 500	1 in 500
March 11	1 in 1000	1 in 1500

In both there was a trifling elevation of temperature, but no wave of fever.

Remarks.—In none of these eight monkeys was any fever produced as the result of these injections, though a slight rise of temperature was observable. I append a chart of Monkey No. 40, which is typical of the others.



In the case of the two monkeys injected with filtered broth cultures, low agglutination reactions were developed, 1 in 20 and 1 in 80 being the highest respectively developed.

In the case of the monkeys injected with broth cultures killed by heat, higher agglutinations were developed, 1 in 30 and 1 in 400 being the highest respectively obtained.

In the case of monkeys injected with heat-killed agar cultures, the highest agglutination reactions of all were realised, 1 in 250, 1 in 400, 1 in 1000, and 1 in 1500 being the highest respectively developed, closely approximating to those obtained in the case of monkeys injected with living *Micrococcus melitensis.*

Conclusion.—The toxins of *Micrococcus melitensis* do not produce the same clinical phenomena as living *Micrococcus melitensis*, no fever being developed, and the production of agglutinins being less.

A Possible Protective Vaccine.

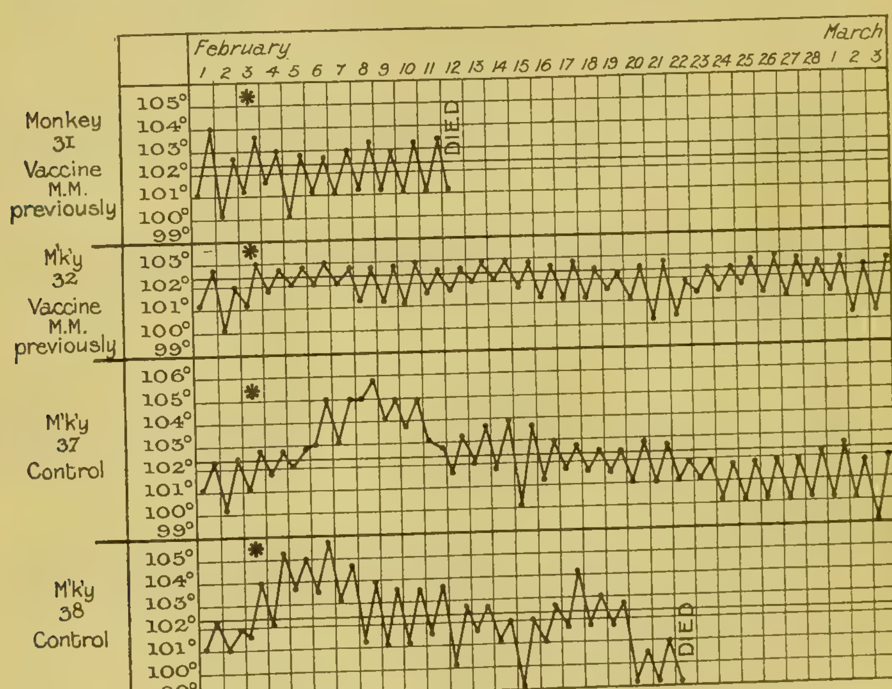
The immunity experiments having indicated that one attack of fever conferred a certain degree of protection against subsequent infection, it remained to be seen if the subcutaneous injection of dead cultures of *Micrococcus melitensis* developed any degree of protection.

As injections of dead agar cultures developed much higher reactions than did dead broth cultures, indicating a higher degree of reaction on the part of the organism to the former than to the latter, the monkeys injected with agar cultures killed by heat were taken for experimentation.

Monkeys Nos. 31 *and* 32, which had each on November 4, 1905, received half of the then heat-killed six-day *Micrococcus melitensis* growth of one agar slope as described in the preceding section, each on December 5 received the growth from one agar slope similarly prepared; and on December 30 this was identically repeated. These subsequent injections never caused any fever. The agglutination reactions follow later.

On the morning of February 3 each of these two monkeys received subcutaneously one-sixth of the growth of *Micrococcus melitensis* from one agar slope, first generation, from human spleen incubated for five days; two normal monkeys, Nos. 37 and 38, each receiving at the same time the same dose to act as controls.

I attach a comparative chart showing the subsequent course of temperature in all four, from which it will be seen that while each control monkey developed a typical wave of fever, neither of the vaccine monkeys did so.



* On this date, February 3, each monkey received the same dose of living *Micrococcus melitensis*.

The course of agglutination in the four monkeys was as follows:—

Date.	Monkey No. 31.	Monkey No. 32.	Monkey No. 37.	Monkey No. 38.
November 19	1 in 250	1 in 400	No observation	No observation
November 26	1 in 250	1 in 400		
December 3	1 in 100	1 in 200		
December 5	2nd injection of dead *Micrococcus melitensis.*			
December 10	1 in 50	1 in 200		
December 24	1 in 40	1 in 100		
December 30	3rd injection of dead *Micrococcus melitensis.*			
December 31	1 in 40	1 in 240		
January 7	1 in 240	1 in 400		
January 14	1 in 300	1 in 800		
January 21	1 in 300	1 in 400	Nil	Nil
January 28	1 in 500	1 in 800	Nil	Nil
February 3	1st injection of living *Micrococcus melitensis.*			
February 4	1 in 600	1 in 700	Nil	Nil
February 7	1 in 1200	1 in 800	Nil	1 in 30
February 11	1 in 600	1 in 1200	1 in 160	1 in 600
February 12	Died	—		
February 18	—	1 in 1000	1 in 500	1 in 1500
February 22	—	—		Died
February 25	—	1 in 1200	1 in 800	
March 9......... ...	—	—	Died	
March 11.............	—	1 in 1000		

Monkey No. 31 on January 28, prior to its first injection with living *Micrococcus melitensis,* was noticed to be unwell.

February 4. The note is "still seedy, no diarrhœa."

February 11. Very "seedy," some diarrhœa; brought from terrace into laboratory for warmth.

February 12. Died. *Post-mortem.* Spleen enlarged. Miliary tuberculosis of lungs. Inoculations from all organs and lymph glands.

February 17. *Micrococcus melitensis* recovered from all glands and organs save kidneys.

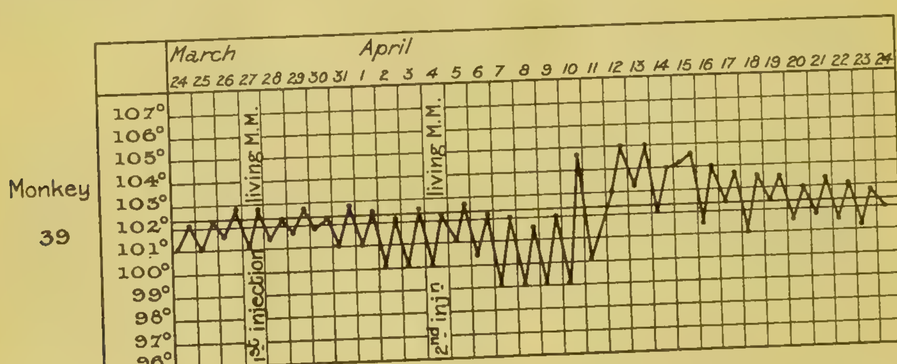
Monkeys Nos. 37 and 38, the controls. The history of these two animals will be found under the section on "A Therapeutic Serum."

Second Experiment.—Monkeys Nos. 39 and 40 were similarly treated with *Micrococcus melitensis* killed by heat, each receiving on February 19 half the product of one agar slope, a four-day growth, second generation, from human spleen (Dakin). This was repeated in each case on March 13.

Monkey No. 40.—Agglutination first appeared on February 25, six days after first injection of dead *Micrococcus melitensis,* in a limit dilution of 1 in 50, rising to 1 in 500 on March 4 and 1 in 1500 on March 11. It unfortunately died from dysentery on March 20. The usual *post-mortem* inoculations were made from all glands and

organs, but no *Micrococcus melitensis* was recovered, thus further verifying the previous death of the *Micrococcus melitensis* injected in both cases.

Monkey No. 39.—Agglutination reaction first appeared on February 25 in a limit dilution of 1 in 30, rising to 1 in 500 on March 4 and 1 in 1000 on March 11, falling after the second injection to 1 in 400 on March 25. On March 27 this monkey received 1 c.c. (representing one-fifth of one slope) of an emulsion of living *Micrococcus melitensis*, four-day growth, second generation, from human spleen (Dakin). On March 30 it appeared unwell and was brought from the terrace to live in a big box in the laboratory. Its agglutination reaction was 1 in 600 on April 1. Its temperature having remained undisturbed for eight days after the first injection of living *Micrococcus melitensis*, that is the outside incubation period for subcutaneous inoculation having been passed, it was decided to give it a second subcutaneous injection of living *Micrococcus melitensis* in order to see if the apparent resistance would be overcome or not. Accordingly on April 4 it received another dose precisely similar to that of March 27, and on April 10, exactly six days after, it commenced a wave of fever. Its resistance had been overcome by the additional dose of living *Micrococcus melitensis*.



The appended chart shows the temperature from a few days prior to the first injection of living *Micrococcus melitensis* and to the end of the wave of fever. It was recorded from February 16 onwards twice daily, remaining normal till April 10. The agglutination reaction was 1 in 500 on April 8 and 1 in 500 on April 15.

Remarks.—Considering the enormously large doses of living *Micrococcus melitensis* administered in these experiments without producing the characteristic wave of fever in the monkeys protected by previous injections of the dead organism, it must be conceded that there is an extremely hopeful outlook for the future of similar protective inoculations of mankind against this fever.

III. FURTHER OBSERVATIONS ON GOATS, CATS, RATS, AND AMBULATORY CASES IN CONNECTION WITH MEDITERRANEAN FEVER.

By Staff-Surgeon E. A. SHAW, R.N.

GOATS.

The Advisory Committee having suggested the advisability of making observations to determine whether or not there existed a seasonal prevalence of Mediterranean Fever amongst goats such as exists amongst men, I proceeded during the first week in March, 1906, to re-examine the goats supplying milk to Bighi Hospital in order to be able to compare the winter prevalence then found with the summer prevalence previously ascertained by me in the same group of goats in June to July, 1905.

This examination was commenced on March 3 and finished on March 11. At this period 74 goats were supplying milk to this hospital as against 91 goats at the previous examination. The component herds were the same on both occasions, but the smaller number in the winter was due to the larger average yield of milk per goat at this period associated with a somewhat smaller number of patients in hospital. The result of this second examination of goats was as follows:—

Date of examination.	Serial number of goat.	Number of *Micrococcus melitensis* colonies recovered.
March 3, 1906	3	Innumerable
March 3, 1906	4	6 colonies
March 4, 1906	22	27 "
March 4, 1906	33	12 "
March 4, 1906	36	2 "
March 4, 1906	38	76 "
March 5, 1906	42	3 "
March 5, 1906	63	241 "

Thus in March eight goats out of 74, or 10·8 per centum, were found to contain living *Micrococcus melitensis* in their milk, as against nine out of 91, or 9·9 per centum, in June to July. There is thus no appreciable indication of a seasonal prevalence affecting this group of goats, but the number of animals here examined is small, and will have to be taken in connection with results obtained by the other workers who have been making a similar re-examination of the groups of goats examined by them last summer.

The history of the two experimental goats continued from my last

report* is briefly as follows:—The elder brown goat ♀ again received subcutaneously, on November 21, 1905, the emulsified six-day growth from six agar slopes of *Micrococcus melitensis* (human spleen growth, third generation); its agglutination was on this date 1 in 2500, on December 3, 1 in 4000, and on December 24, 1 in 3000. On December 26 it similarly received the five-day growth from two slopes of second generation from a race of *Micrococcus melitensis* very virulent for guinea-pigs, obtained from Dr. J. W. H. Eyre, of Guy's. This developed a "negative phase," the agglutination reaction dropping to 1 in 800 on December 31, rising to 1 in 1000 on January 7, 1906, and 1 in 2000 on January 14, 1 in 2000 on February 18, 1 in 3000 on March 11, and 1 in 3000 on April 15. This animal, not having been impregnated since its purchase in June, 1904, has yielded no milk since June, 1905, and has been treated as above described for the sake of its serum.

[*Note.*—On May 26, 1906, this goat, which was suffering from a localised subcutaneous abscess at the site of the last inoculation, was slaughtered.

Post-mortem.—Cultivations from spleen and mesenteric glands gave profuse growth of *Micrococcus melitensis.* Cultures from inguinal glands and the cheesy material from the abscess cavity remained sterile. Blood gave a serum reaction of 1 in 1000.]

An Impregnation and Natural Feeding Experiment.

The younger white goat ♀, now mature, was sent in October, 1905, to be impregnated. On November 21 it received the emulsified growth from four slopes of the same *Micrococcus melitensis* as its companion (*vide* supra); its agglutination was then 1 in 1000, 1 in 1000 on November 26, 1 in 800 on December 3, 1 in 1000 on December 10, 1 in 1500 on December 24. On December 26 it received one slope of same strain of *Micrococcus melitensis* as its companion. Its agglutination was 1 in 2000 on December 31, 1 in 1500 on January 7, 1906, 1 in 3000 on January 14, and 1 in 1500 on February 18. On February 7, 5 c.c. of blood were taken aseptically from its right external jugular vein and incubated in broth. *Micrococcus melitensis* was recovered and verified from this. On March 2 it was delivered of a kid; its agglutination on this date was 1 in 1000. The new-born kid's blood was taken and examined for agglutination reaction; this was found to be present in a limit dilution of 1 in 800, thus being slightly less than that of the mother. Agglutinins had thus passed from the maternal to the fœtal blood, *via* the placental circulation. It now remained to see if the *Micrococcus melitensis* demonstrated to have been present in the mother's blood during pregnancy had similarly entered the fœtal circulation. The kid, born March 2, was chloroformed on

* See Part IV of Commission Reports.

March 4, and the usual *post-mortem* inoculations made from the axillary femoral and mesenteric lymphatic glands, and from the spleen, liver, kidneys, urine, and heart's blood, 36 Petri dishes and 12 broth tubes being used for this purpose. *Micrococcus melitensis* was not recovered, the tubes and plates all being sterile with the exception of two which contained a few accidental, apparently air, contaminations.

Micrococcus melitensis did not appear to have passed into the fœtal circulation though present in the maternal blood.

[*Note.*—Up to June 27 the milk from the white goat was examined regularly twice a week, but *Micrococcus melitensis* was never detected in the plates prepared from it. The kid, whose blood had likewise been examined twice a week and invariably given a negative reaction when tested in dilutions of 1 in 10, 1 in 20, and 1 in 50, was removed from the white goat on June 17, 1906, and utilised for another experiment.]

On March 6 a new-born black kid from an uninfected mother was examined for agglutination reaction; this not being found present, it was placed with the bereaved mother goat to function as a natural infected milk-feeding experiment, and the two animals were isolated. The milk of the mother was plated twice weekly (four plates each time), commencing March 2. *Micrococcus melitensis* had not appeared in it by April 20, nor had the little kid ever presented any agglutination reaction, though this was periodically looked for. The mother's agglutination reaction went up to 1 in 2000 by March 11, and was 1 in 2000 on April 15.

In consequence of my impending departure from Malta, Dr. Eyre took over all three of these animals from me on April 21, and will continue the experiments.

Cats.

On February 24, 1906, I commenced an examination of cats to ascertain if Mediterranean Fever was to be found affecting them at all. There being no "home" for lost or strayed cats in Malta such as there is for dogs, considerable difficulty was encountered in getting animals in quantity for examination; they could only be got singly and at intervals of days. Up to April 21 I had succeeded in getting 22. Of these five presented an agglutination reaction to *Micrococcus melitensis* in a dilution of 1 in 30. I was able to purchase three of these, chloroformed them, and made the usual *post-mortem* inoculations, using in each case—

4 plates for femoral lymphatic glands.
4 " axillary " "
4 " mesenteric " "
4 " spleen
4 " kidneys
2 " liver
6 broth tubes for heart's blood.

Micrococcus melitensis was recovered and verified from one cat only, and that in very small quantity, three colonies in one of the plates prepared from the mesenteric lymphatic glands. This cat belonged to the mother of one of the laboratory labourers, who was living in Birchircara, a small town three miles from Valletta, but in a house quite apart from that in which her son lived with his family.

Rats.

Early in March, 1906, I made arrangements for obtaining rats from the naval dockyard, the abattoir and the main drains in order to ascertain if these were at all infected with Mediterranean Fever. This examination was commenced on March 7, and up to April 21 I had examined the blood of 43 rats, all of the common dark brownish-grey type usually found in sewers. Of these three presented a faint agglutination reaction in a dilution of 1 in 30 with *Micrococcus melitensis*, and were duly chloroformed and the usual *post-mortem* inoculations from glands and organs made, but no *Micrococcus melitensis* was recovered from any one of them. On March 22 I noticed trypanosomes in the blood of one rat, and have found them in the blood of eight rats out of 26 examined since that date. In one of these eight cases the parasites after staining appeared to be the typical ordinary *Tr. Lewisii* usually found in rats; in the other seven the parasites were all of similar length and breadth, relatively more slender than *Tr. Lewisii* and presenting no such variations of form as the latter usually does.

Ambulatory Cases.

I have continued the examination of two of the ambulatory cases* since their discovery in June, 1905, up till April 20, 1906, when I turned them over to Dr. Eyre on my impending departure from Malta.

These two cases were those (No. 9, B. Worley, and No. 11, F. Mallia) whose urine contained *Micrococcus melitensis* in such extraordinarily large quantities. The urines from both these cases have been collected and samples plated twice weekly throughout the period named, and they have never failed to contain *Micrococcus melitensis*. The amount, as shown in the previous Report, has been very variable. The average number of colonies found at each examination during each month for Case 9, B. Worley, has been as follows:—

1905—October	3000 colonies of	*Micrococcus*	*melitensis*	per c.c.
November ...	2400	"	"	"
December......	4200	"	"	"
1906—January	2800	"	"	"
February	5400	"	"	"
March	1200	"	"	"
April............	540	"	"	"

* See Part IV of Commission Reports.

These numbers have been determined in the manner detailed in the previous Report. The other case, No. 11, F. Mallia, has been under treatment with drugs with a view to seeing if the excretion of living *Micrococcus melitensis* in his urine could be affected, Case 9 being left untreated to function in some degree as a standard of comparison. Urotropine was first tried, then hydrarg. perchlor.; each was given three times a day, the following table shows with what result:—

Dates of drug administration and dose.		Date of plating urine.	Number of colonies of *Micrococcus melitensis* recovered per cubic centimetre of urine.
		1905.	
Dec. 26 to Jan. 14...	2 grains of urotropine three times a day	December 26......	1,200
		December 29......	1,300
		1906.	
Jan. 15 to Jan. 22...	Increased to 15 grains t. d. s.	January 2	900
		January 5	3,600
		January 9	3,600
		January 12	3,600
		January 16	4,800
		January 19	4,800
Jan. 23 to Feb. 5 ...	Increased to 20 grains t. d. s.	January 23	2,400
		January 26	4,200
		January 30	3,000
		February 2	6,000
		February 6	6,000
		February 9	8,400
Feb. 6 to Feb. 26 ...	$\frac{1}{12}$th of a grain of hyd. perchlor. three times a day	February 13	3,600
		February 16	4,000
		February 20	2,400
		February 23	1,200
		February 26	2,000
		March 2	480
		March 6	5,400
Feb. 27 to Mar. 31...	Increased to $\frac{1}{6}$th of a grain t. d. s.	March 9	3,600
		March 13	12,000
		March 16	7,000
		March 20	5,000
		March 23	3,000
		March 26	4,800
		March 30	3,600
April	Treatment suspended	April 2............	4,800
		April 6............	1,200
		April 10............	1,200
		April 14......... ...	Man on leave
		April 17............	600

The number of colonies are approximate, being determined by counting colonies in an average area of 1 cm. square and multiplying out, $\frac{1}{6}$ of a c.c. being distributed over each plate.

It will be seen that the drugs used had practically no effect on the excretion of the living *Micrococcus melitensis*, nor presumably, therefore, on its life in the human body. These two cases have been turned over to Dr. Eyre for further treatment and observations.

IV. *MICROCOCCUS MELITENSIS* AND ANTISERUM.

By J. W. H. Eyre, M.D.

(Received July 2, 1906.)

The first serious attempt to produce an antiserum for therapeutic use in Malta Fever was made by Wright, who, in 1895, treated goats and in the following year a horse by the subcutaneous injection of "killed" cultures of *Micrococcus melitensis*. The serum obtained from the goats appeared to possess but little agglutinative power, and when employed in the treatment of monkeys, either previously or subsequently to the injection of living cultures of the Micrococcus, exhibited neither protective nor curative properties. The serum of the horse was further used in the treatment of patients suffering from Malta Fever, and some of these human cases recorded by Aldridge* in 1898 showed, subsequently to the administration of the serum, improvement which was ascribed to the action of the serum. No further observations or experiments in this direction have, however, been recorded since. In 1903 I commenced a series of experiments dealing with the immunisation of rabbits and of guinea-pigs, in the hope of obtaining a bactericidal serum of demonstrable potency; next were tried goats, and finally, in 1905, I undertook the treatment of a horse. The results obtained to date are by no means so encouraging as was anticipated, but certain points have been established which help to elucidate phenomena observed during the course of experimental work on the Micrococcus, to which points it appears advisable to draw attention.

My early experiments, in which the rabbit as well as the guinea-pig was employed, confirmed Durham's† valuable observations; his results may be summarised as follows, the illustrative cases being taken from my own note-book:—

(*a*) That the development of specific agglutinins in the blood was

* 'Lancet,' vol. 1, 1898, p. 1394.

† 'Journ. of Path. and Bact.,' vol. 5, 1899, p. 377.

slower in rate and less in amount in the most severe and in the least severe infections (compare Animals Nos. 1 and 2, Table I). Speaking generally, the formation of large quantities of agglutinins took place when the resisting power of the infected animals was considerably but not *over* strained.

(*b*) That there was apparently little direct relationship between agglutinins and antitoxic or antibacterial substances, as the blood of infected animals frequently showed a high agglutinative power for some time prior to a fatal termination (see Animals Nos. 3, 4, and 5, Table I).

(*c*) And, finally, that animals whose blood at death possessed a low agglutination index often showed a general blood infection with abundant cocci, whilst it was frequently observed in those with high agglutinative power that cocci were either absent from the blood of the general circulation or present in very small numbers (compare Animals Nos. 1 and 3, Table I).

Occasionally, however, the cocci are present in the peripheral blood in enormous numbers, even when the sedimentation value of the serum is fairly high (see Animals Nos. 4 and 5, Table I).

Table I.

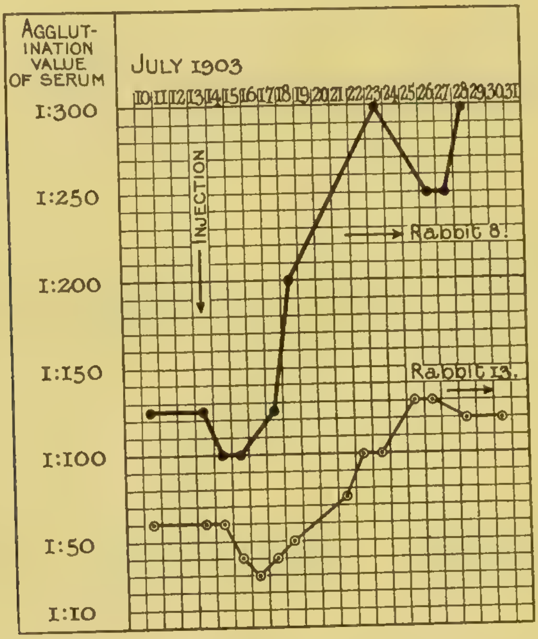
Reference No.	Guinea-pig No.	Dose of living culture.	Method of inoculation.	Sedimentation value of serum.	Interval between inoculation and death.	Number of cocci per 10 cm. heart blood at death.
		loop.				
1	63	1	Intracerebral	1 : 10—	10 hours	6000
2	12B	0·001	„	1 : 500 +	28 days	Nil
3	15	1	„	1 : 1100 +	27 hours	3
4	90	1	„	1 : 600 +	4 days	500
5	19C	1	„	1 : 1000 +	21 „	1000

In addition it was found that the intravenous injection of graduated doses of killed cultivations of *Micrococcus melitensis* provoked the formation of agglutinins (though, speaking in general terms, in lesser quantities than followed the injection of suitable doses of living cultures), and that after agglutinins had been formed in demonstrable quantities, the immediate effect of the introduction of a further dose of killed culture was to temporarily diminish the quantity of agglutinins present in the serum, and its more remote effect to provoke a marked increase (see Chart I). Again, it was often observed that if the injections were too frequently repeated, this immediate diminution was cumulative (see Chart II), conclusively showing that the

formation of agglutinating substances for *Micrococcus melitensis* followed the same laws as those of typhoid, dysentery, and other better-known agglutinins.

After the long-continued treatment of the rabbit by repeatedly injecting suitable doses of killed cultures, and the establishment and maintenance of a high agglutinative power in the blood, the introduction of even comparatively small amounts of living virulent cultures

Chart I.



Showing the immediate and remote effects upon the sedimentation index of the experimental rabbit of 2 milligrammes "killed" cultivation of *Micrococcus melitensis* administered intravenously.

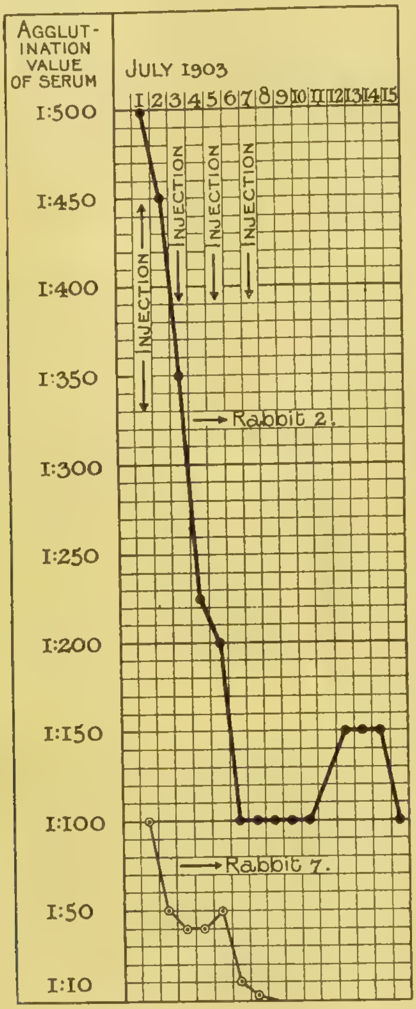
almost invariably caused the death of the animal, whilst the highly agglutinating blood serum of the treated animals failed to protect normal rabbits against infection or modify the course of such infection.

E.g., Rabbit No. 8, weight 3000 grammes, under treatment for seven months, litre of serum = 1 : 1500, received one loop of a three-day old agar culture of *Micrococcus melitensis* intracerebrally. Death occurred in 10 days from *Micrococcus melitensis* septicæmia, and *post-mortem* all the organs and tissues were found to be crowded with the micrococci.

The difficulties in the way of obtaining serum in sufficient quantity from the rabbit for extensive tests of its influence on the course of infections resulting from the injections of other animals with *Micrococcus melitensis* led me to attempt the immunisation of goats, employing at first the method of intravenous injection of killed cultures of *Micrococcus melitensis*. After five months' work it was

found that the agglutinative power of the blood serum could not be pushed much beyond 1 : 200, although the amount of inoculum introduced at the latter injections was equivalent to the entire bacterial growth of one Roux culture bottle. The subsequent injection

Chart II.



Showing the effects produced upon the sedimentation index of the experimental rabbit by the repeated injection of small doses of living cultivations of *Micrococcus melitensis* (0·001 of a loop).

Note.—**Rabbit No. 2 died July 30. *Micrococcus melitensis* recovered in large numbers from all organs.**

Rabbit No. 7 died August 28. *Micrococcus melitensis* not recovered.

intravenously of living cultures elicited no adequate response, although it yielded the further information that the coccus remained alive in the general circulation and could be recovered from the peripheral blood of the animal at least a month after injection. On the other hand, owing to the low virulence of the culture of *Micrococcus melitensis*

with which I was working, the course of the infection in the experimental animals extended to months, and it became impossible to ascribe therapeutic value to the goat's serum when an animal treated therewith survived the control by two or even three months—even when at the *post-mortem* examination cocci were absent from the organs, bone marrow, and urine, for similar findings were not infrequently recorded in the control guinea-pigs.

Under these circumstances I directed my attention to the exaltation of the virulence of the *Micrococcus melitensis* for the guinea-pig, with the result (as detailed in a previous paper in these Reports—Part II, p. 67) that a loop holding some 0·5 milligramme of culture could be depended to produce death within seven days. Such a dose, although obviously not the minimal fatal dose, is referred to as the "standard" dose.

A chestnut mare was purchased by the Commission at the end of March, 1905, and after satisfactorily passing the tuberculin and mallein tests its serum was tested against an emulsion of *Micrococcus melitensis* and was found to be totally devoid of agglutinative power on the coccus, even when equal quantities of the serum and emulsion (1 : 2) were placed in contact. Treatment was begun on April 3 by the subcutaneous injection of 10 milligrammes of *Micrococcus melitensis* culture, previously suspended in 10 c.c. saline solution and killed by heating to 59° C. for 30 minutes in water bath. In this connection I may mention that the strain of *Micrococcus melitensis* used throughout these horse injections was the one, highly virulent for guinea-pigs, mentioned above.

At intervals of about one week, the exact time being determined by attention to such points as the general condition of the mare, temperature, etc., the injection was repeated and the size of the dose of killed culture gradually increased until after nearly two months' treatment it had reached 250 milligrammes. The quantity of agglutinins formed in response to these injections was, however, small, and a complete reaction could not be obtained in higher dilutions than 1 : 5. The seat of inoculation was then changed, and 18 milligrammes of dead cocci injected directly into the external jugular vein, with the result that the agglutinins immediately increased in amount and the sedimentation curve rose to 1 : 100. Living cocci from three-day old agar cultivations were then substituted for the "killed" cultures, and were injected intravenously (gradually increasing doses from 5 milligrammes up to about 3000 milligrammes being introduced on 10 separate occasions during the following six and a-half months), and in this series the interval between the injections was regulated by the movements of the sedimentation curve, which invariably responded to an injection in the manner already referred to and graphically represented in Chart I. The

details of the 18 injections are summarised in the accompanying table (II).

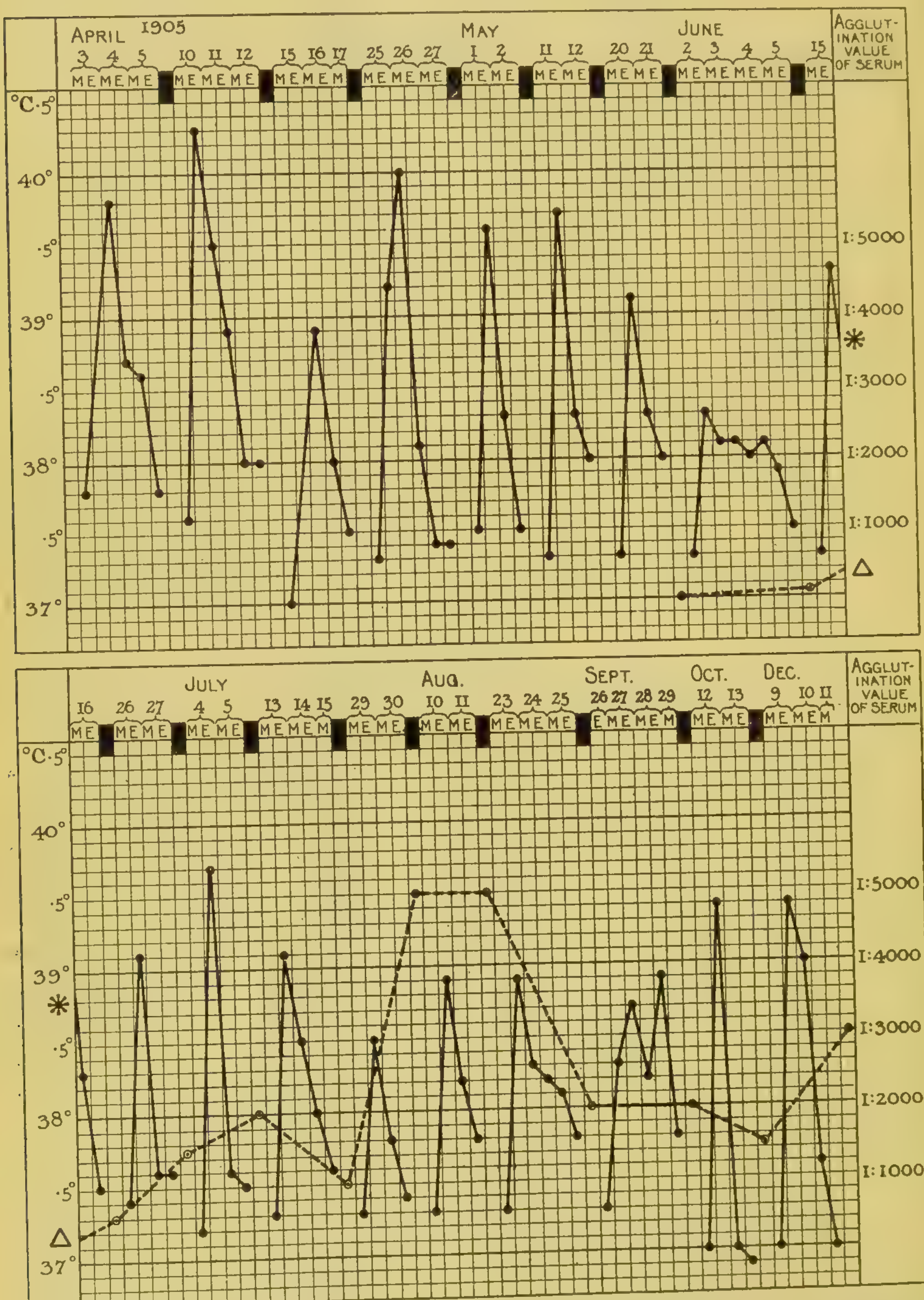
Table II.—Details of Horse Inoculations.

No. of inoculation.	Date.	Character of inoculum.	Approximate size of dose of cocci.	Bulk of emulsion injected.	Site of inoculation.	Resulting sedimentation value of serum.
			mg.	c.c.		
1	3/4/05	"Killed" cultivation	10	10	Subcutaneously	1 : 2 –
2	10/4/05	"	25	10	"	1 : 2 –
3	15/4/05	"	25	10	"	1 : 2 –
4	25/4/05	"	50	20	"	1 : 2 –
5	1/5/05	"	100	50	"	1 : 2 –
6	11/5/05	"	100	50	"	1 : 2 –
7	20/5/05	"	250	50	"	1 : 5 +
8	2/6/05	"	18	10	Intravenously	1 : 100 +
9	15/6/05	Living cultures	5	20	Intravenously	1 : 600 +
10	26/6/05	"	5	10	"	1 : 1500 +
11	4/7/05	"	10	25	"	1 : 2000 +
12	13/7/05	"	25	50	"	1 : 1000 +
13	29/7/05	"	25	50	"	1 : 5000 +
14	10/8/05	"	50	50	"	1 : 5000 +
15	23/8/05	"	50	50	"	1 : 2000 +
16	26/9/05	"	1250	50	"	1 : 2000 ±
17	12/10/05	"	1250	50	"	1 : 1500 +
18	9/12/05	"	3000	100	"	1 : 3000 +

The clinical phenomena exhibited by the animal subsequently to an injection were remarkably few. The temperature invariably rose within a few hours of the injection, but rarely more than 1°·5 to 2° C., and the mare was "off her feed" for perhaps 24 to 36 hours. The temperature rapidly fell, and was again normal within two or three days. After a subcutaneous inoculation of the dead bodies of the cocci a small local swelling appeared in about 12 to 18 hours, which was tender and "boggy" to the touch. This was soon absorbed as a rule, but on one occasion it persisted for some days, became conical in shape, and the apex of the cone became so soft as to induce me to incise at this point. No pus, however, was present; cultures from the œdematous subcutaneous tissue remained sterile, and the wound rapidly healed. On another occasion the emulsion of living cocci was prepared with sterile distilled water instead of normal saline solution and injected intravenously, with the result that a certain amount of thickening occurred along the course of the external jugular vein, requiring nearly a week for its complete absorption, and causing a heavy fall in the sedimentation value of the serum.

Beyond these two mishaps nothing occurred to disturb the progress of treatment, and in February, 1906, some six weeks after the final bleeding, the mare had immensely improved in weight, general appearance, and spirit since her purchase by the Commission.

Chart III.



Showing the response of the temperature (continuous line) and sedimentation (interrupted line) curves of the Malta Fever mare to each of the 18 injections. The average temperature of the normal horse is 37°·57 C. (Sims Woodhead, 'Proc. Physiological Soc.,' vol. 23, 1899, pp. 15—18.

In the accompanying chart I have abstracted the movements of the curves of the temperature, and of the sedimentation value of the serum, corresponding to each individual inoculation.

In addition to the samples of blood frequently abstracted to determine the amount of agglutinins present, larger quantities (some 250 c.c.) were drawn at intervals, and on the separation of the serum tests were made in the first place of its sterility and in the second of its protective properties. With reference to the first point, so far as could be determined by plate and tube cultivations, the serum, when carefully decanted from the blood clot, was absolutely sterile, but the injection of animals showed that a sufficient number of micrococci were present in the blood serum when this had been drawn within about three weeks of an inoculation to cause a fairly acute infection, but that by the end of about four weeks after injection, the horse had been able to remove all living cocci from the general circulation, and the serum was then innocuous and presumably sterile.

These results may be conveniently tabulated as follows :—

Table III.

Date.	Animal and number.	Injected with horse serum. Quantity.	Injected with horse serum. Obtained—days since last injection.	Method of inoculation.	Result.
		c.c.			
23/8/05	Guinea pig 16	10	13	Subcutaneously	Death in 3 days, *M. melitensis* recovered.
,,	,, 57	10	13	,,	Death in 2 days, *M. melitensis* recovered.
15/9/05	,, 64	10	21	,,	Death in 3 days, *M. meli. tensis* recovered.
22/9/05	,, 16A	10	28	,,	Animal unaffected—serum absorbed.
24/11/05	,, 17	10	28	,,	Animal unaffected—serum absorbed.
,,	Rabbit 171 ...	10	28	Intravenously	Animal unaffected.

Note.—It was probably during the dilution of the serum drawn on August 20 in readiness for me to determine its sedimentation value, or during the performance of the *post-mortem* on guinea-pigs Nos. 16 and 57, that my colleague, Dr. Price Jones, became infected, and 15—17 days later developed a typical attack of Malta Fever.

The question of protective properties may be easily dismissed. In no case up to the present (and some 20 guinea-pigs were employed

for the experiments with the serum obtained in February last) did the subcutaneous injection of even large quantities of the serum, 10 c.c. and 20 c.c., prevent the subsequent infection of the experimental animal by a "standard" dose of *Micrococcus melitensis* injected intracerebrally, or do more than slightly retard the fatal termination. When, however, 0·1 c.c. of serum and a "standard" dose of Micrococci were simultaneously introduced into the cerebral tissue the animal remained unaffected.

Table IV.

Guinea-pig No.	Dose of culture.	Method of inoculation.	Dose of serum.	Method of injection.	Result.
	loops.		c.c.		
140	1	Intracerebrally	5	Subcutaneously	Death in 6 days, *M. melitensis* recovered.
141	2		5	"	Death in 36 hrs., *M. melitensis* recovered.
142	1		0·1	Intracerebrally	Unaffected.
143	1		—	—	Death in 36 hrs., *M. melitensis* recovered.

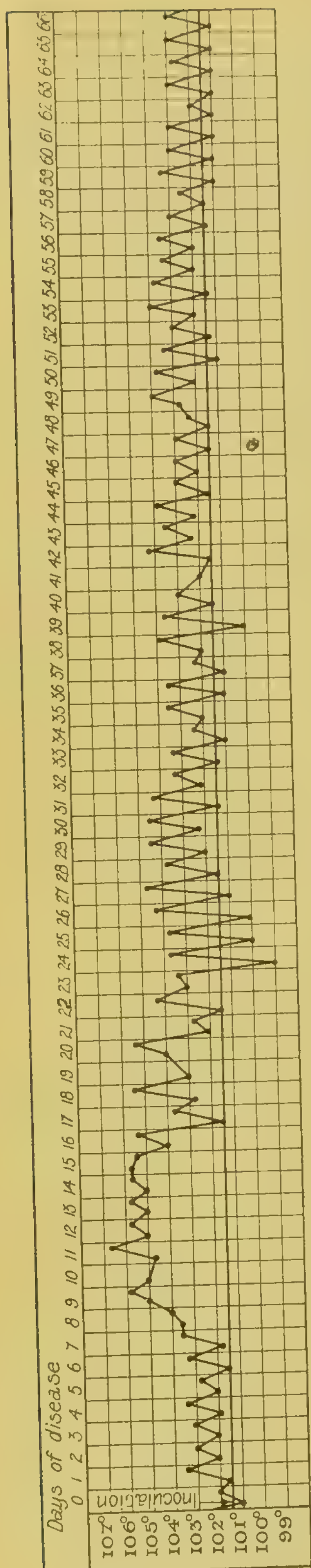
The possible possession of therapeutic properties by this serum was next investigated experimentally.

Addendum, October, 1906.

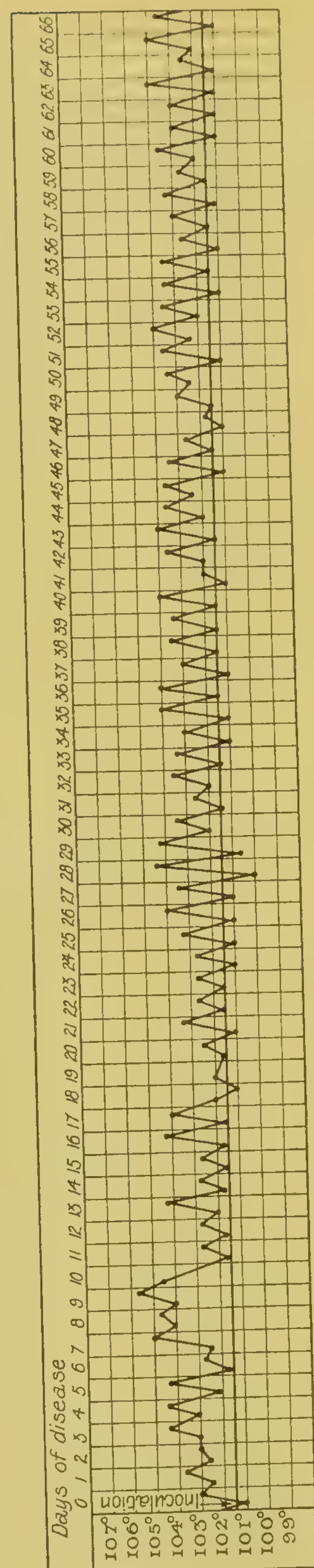
Six healthy monkeys (*Macacus rhesus*) were selected, and each injected subcutaneously with 0·1 of a loopful of cultivation of *Micrococcus melitensis* (grown for 24 hours at 37° C. on an agar slope), emulsified in 1 c.c. normal saline solution. The animals were numbered 1 to 6 inclusive. Eight days later, when signs of successful infection—rise of temperature, appearance of agglutinins in blood, etc.—were apparent, Nos. 1 and 2 were set aside for observation as controls; Nos. 3, 4, and 5 received 3 c.c. horse serum subcutaneously daily for eight days, and No. 6 received 3 c.c. horse serum injected directly into the external saphenous vein daily for a similar period. The result was by no means encouraging, and is well shown in the accompanying series of charts, for while Monkey No. 4 showed a comparatively even temperature and an absence of marked pyrexia that might be attributed to the action of the serum, the charts of the remaining three serum-treated monkeys show no marked differences, so far as concerns the range and duration of pyrexia, from those of the two controls, while throughout the course

of the experiment simple visual observation of the infected animals was insufficient to enable one to distinguish between those treated with serum and the controls.

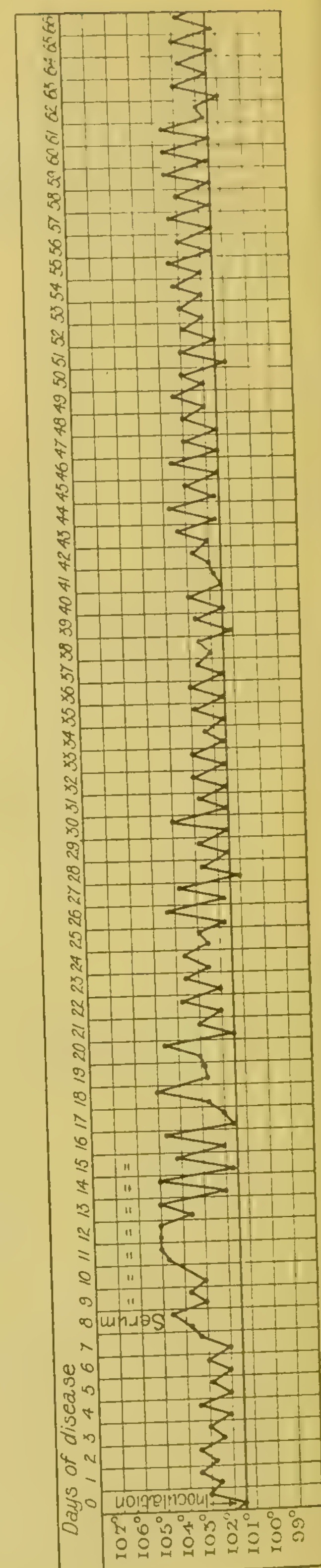
The serum was also used in the treatment of one human case, but beyond steadying the pulse and bringing it down from 108 to 96 per minute, a result which might equally well have been achieved by a simple injection of normal saline solution, no further effect could be detected.


Days of disease
Inoculation
107°
106°
105°
104°
103°
102°
101°
100°
99°

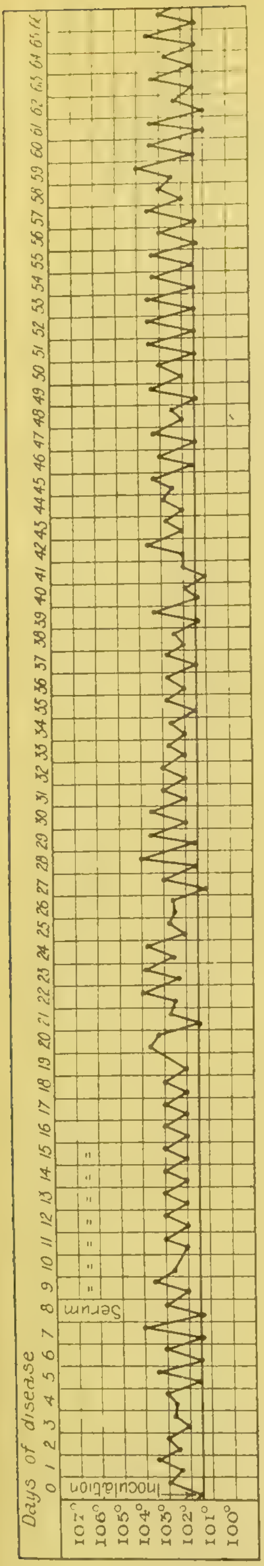
Monkey 1


Days of disease
Inoculation
107°
106°
105°
104°
103°
102°
101°
100°
99°

2

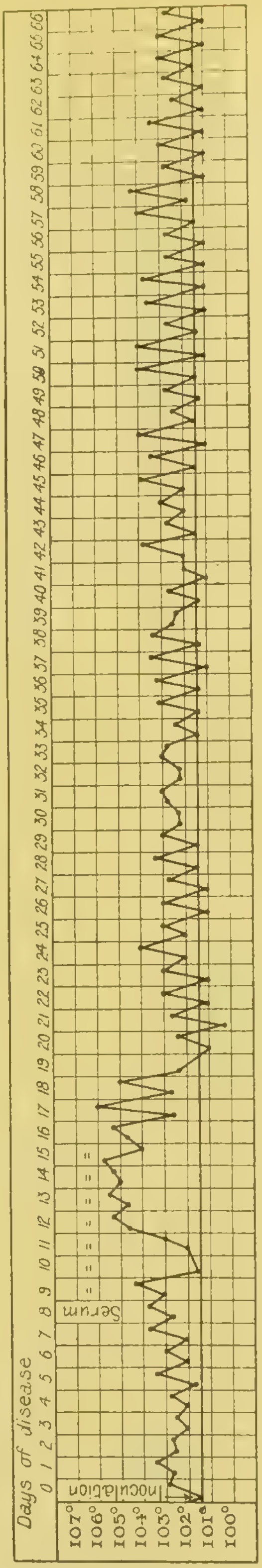

Days of disease
Inoculation
Serum
107°
106°
105°
104°
103°
102°
101°
100°
99°

3



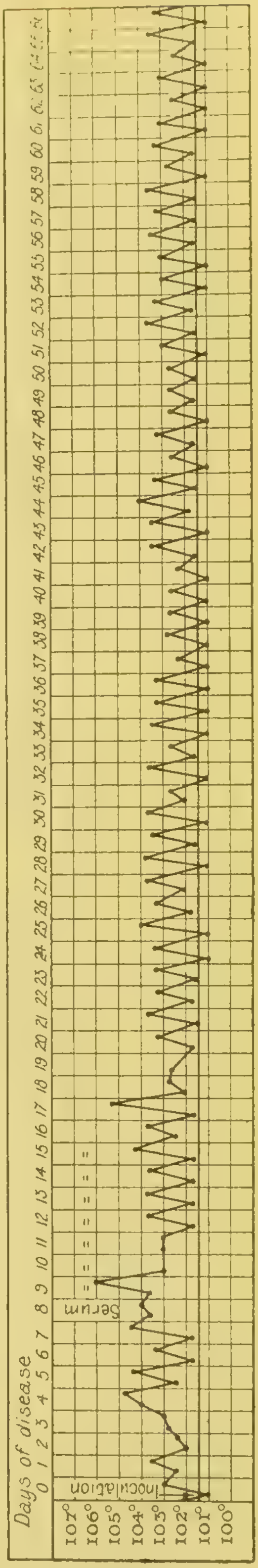
Days of disease
Inoculation
Serum
107°
106°
105°
104°
103°
102°
101°
100°

Monkey 4



Days of disease
Inoculation
Serum
107°
106°
105°
104°
103°
102°
101°
100°

5



Days of disease
Inoculation
Serum
107°
106°
105°
104°
103°
102°
101°
100°

6

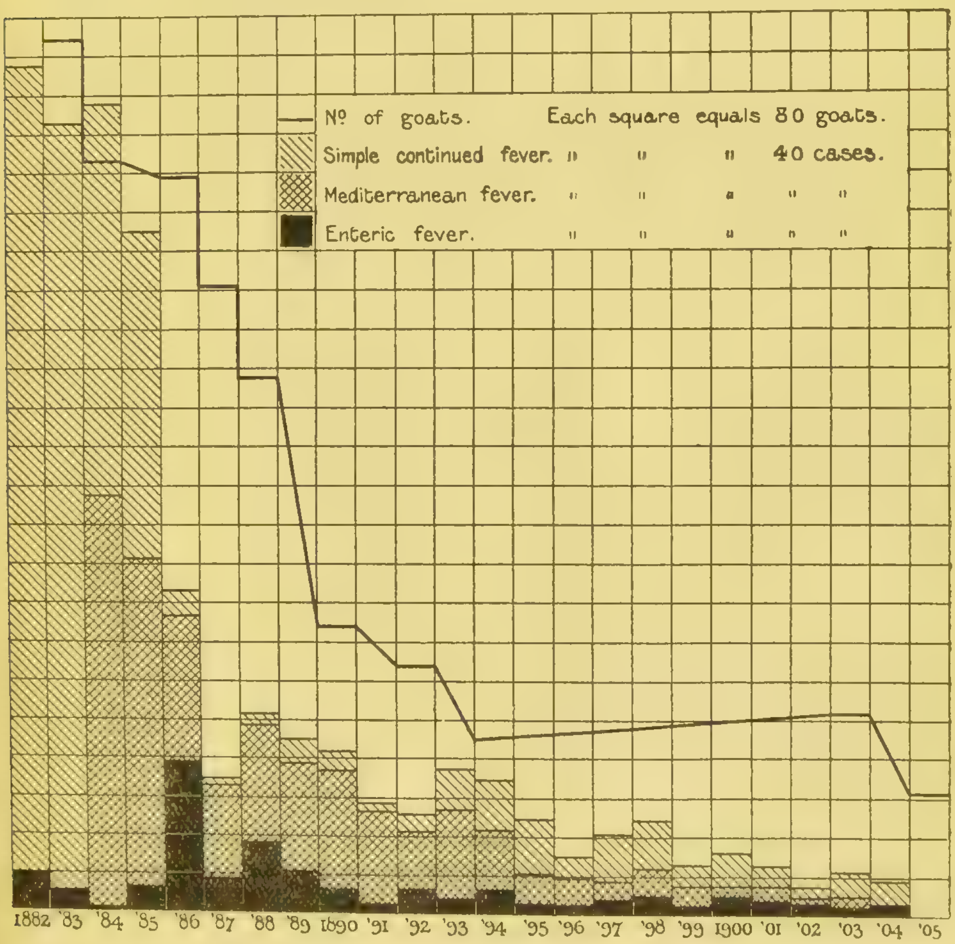
V. MEDITERRANEAN FEVER IN GIBRALTAR.

By Major W. H. HORROCKS, R.A.M.C.

Mediterranean Fever, often called "Rock Fever," has existed in Gibraltar for many years. Although the cause of the disease was not known until Bruce isolated the *Micrococcus melitensis* from fatal cases in Malta, medical men practising on the Rock knew of the existence of a fever which was characterised by long duration, low mortality and liability to be followed by rheumatic sequelæ. In the Army Medical Department Report for 1878, it is stated that many of the cases of rheumatism were of an obstinate nature following attacks of Mediterranean Fever, and in the Report for the year 1880 mention is made of 194 cases of rheumatism associated with previous attacks of "Rock Fever." The civil health reports, furnished 25 years ago, do not contain any references to Mediterranean Fever, but in the Report for 1883 there is a statement that the civil population suffered from marked outbreaks of a fever which was not enteric fever and had a very low death-rate. An examination of the returns of the Colonial Hospital shows, however, that the local fever was rarely admitted into that institution. Dr. Turner, the senior colonial surgeon, wrote in a paper on the Rock Fever of Gibraltar, published in 1883, "amongst the indigent poor of the civil community residing in the central districts of the town, I have attended at their homes during 1882 and 1883 over 900 cases of illness; of these 115 have been attributed to continued fever and but two have died. My experience in practice among the upper classes yields similar results. . . . Rheumatism is undoubtedly present in varying degrees of intensity in a large proportion of the cases." There can be no doubt that Mediterranean Fever, as we know it now, was very prevalent both among the civil and military populations some 25 years ago. But as the continued fevers were neither reported to the health officer nor admitted into the Colonial Hospital, except the cases were very severe, it is necessary to examine the military statistics in order to obtain an idea of the real prevalence of the disease. Until the year 1897, when serum diagnosis was practised, the fevers occurring among the military population were returned under the headings, Febricula, Simple Continued Fever and Enteric Fever. The term Remittent Fever was not much used except in connection with cases of fever developing in regiments which had recently arrived from stations where malaria was prevalent.

Unfortunately, the term Simple Continued Fever was used for

febrile attacks of short duration as well as for cases of prolonged fever attended by marked anæmia and complicated by rheumatism, so that in order to make a reliable estimate of the probable number of cases of Mediterranean Fever it has been necessary to examine the Army Medical Reports, the Admission and Discharge Books and the Case Books preserved in the military hospital. A careful examination of these records from the year 1884, shows that if cases of simple continued fever in hospital for 14 days and under are eliminated, a large number of cases remain which are almost certainly Mediterranean Fever. A few cases in hospital for 16 to 20 days are doubtful, but as similar cases observed during the last three or four years gave a serum reaction with the *Micrococcus melitensis*, they have been included in the Mediterranean Fever group. Prior to the year 1884 Admission and Discharge Books are not available, so it is only possible to obtain a general idea of the wave of total fevers on the Rock from the Army Medical Reports. The figures given show that a wave of fever commenced in 1874 and reached a maximum in 1882 when 902 cases of fever were recorded. On the attached chart the total number of cases of continued fever are shown from 1882 to 1905, and from



the year 1884 the proportional parts which enteric fever, Mediterranean Fever and simple continued fever bear to the whole are represented by uniform shading, crossed lines and simple diagonal lines respectively. It will be seen that in the year 1884 there were 833 cases of continued fever, of which 429 were probably Mediterranean Fever. In 1885 there were 697 cases of continued fever, including 341 cases of Mediterranean Fever. In the year 1886, however, there were only 331 cases of continued fever, and of these 158 were returned as enteric fever. The great increase in the number of cases was attributed partly to an infected regiment arriving on the Rock after service in the Egyptian War, and partly to serious sanitary defects in Town Range, Hargreaves, and Buena Vista Barracks. The figures are probably correct, as 26 deaths occurred among the 158 cases of enteric fever. Besides the marked decrease in the number of cases of Mediterranean Fever, the year 1886 is also remarkable for the practical extinction of simple continued fever. In 1887 there was again a considerable fall in the number of cases of Mediterranean Fever, and from that date, with slight oscillations, the curve of Mediterranean Fever gradually declined until it reached zero in 1904.

During the years under review the military population varied between 4,307 in 1886 and 5,031 in 1901, and at the time when the most marked fall in the fever curve occurred the population averaged 4,724. The rapid disappearance of febrile diseases from the Rock, which commenced in 1885, forms a marked contrast to the state of things in Malta during corresponding years. It is plain that some important cause of fever, which has vanished from Gibraltar, has continued to operate in Malta.

Having discovered (1) that the *Micrococcus melitensis* is excreted in urine of men and goats and that animals can be infected by dust contaminated with urine of patients suffering from Mediterranean Fever, and (2) that the *Micrococcus melitensis* is excreted in the milk of infected goats and that the consumption of this milk causes Mediterranean Fever in monkeys, it is evident that both sanitary conditions and possible infection of goats on the Rock must be investigated if the key to the problem is to be found.

Sanitary Conditions of the Rock.

Military Districts.—An examination of the Army Medical Department Reports shows that during the past 30 years there has been a gradual improvement in the sanitary condition of the military districts. In 1872–3 a main drain was made at the New Mole and glazed pipes were used; the joints, however, were made with clay and bedded in mortar. In 1886 the drainage of Town Range, Hargreaves, and Buena Vista Barracks was improved and the waste pipes of ablution rooms were disconnected from sewers. In 1887 the Principal Medical Officer

reported that "the whole system of soil drains requires to be thoroughly overlooked, and nothing short of laying down new soil pipes can possibly meet the urgent requirements under this head . . . the present soil drains of *brick* are defective." In 1888 he stated that "a considerable number of sanitary improvements were effected in the different barracks during the year, principally as regards improvements in drainage, both by structural alterations and ventilation of existing drains." It was customary to make the joints in drainage work with clay up to the year 1890, and most of the drains were of the chair and saddle type. Fresh-air inlets, with mica flaps, for drains were first used about the year 1890. It is evident that up to the year 1888 the military drainage was extremely faulty, and the new work done up to the year 1890 still permitted pollution of the soil owing to the use of clay joints.

Civil Districts.—Up to the year 1865 the civil drains and sewers were constructed with bricks on the box pattern, and the sewage was discharged into the "Bay" on the west side of the Rock. During the years 1865–8 the box drains were removed and earthenware pipes of the chair and saddle type were laid in the north district of the town. A similar change was made in the south district during the years 1870–4. At that time there was no disconnection of house drains from tributary sewers, but in the year 1883 Weaver's siphon trap was installed on civil premises. In 1893 the building bye-laws were passed, and the chief requirements of the Local Government Board model bye-laws were then insisted upon. Fresh-air inlets for house drainage, 4-inch soil pipes placed outside houses, and W.C.'s with separate flushing tanks had to be provided in houses occupied by the civil community. In the year 1896 the new main sewer discharging the town sewage on the east side of the Rock was commenced, and the work was completed in 1898.

As the curve representing febrile diseases amongst the military population steadily rose from 1874 to 1884, it is unlikely that the improved civil drainage was the principal cause of the reduction of fever that suddenly commenced in 1885. The disconnection of civil premises from tributary sewers may have had an influence in diminishing febrile attacks among the civil population. Up to and including the year 1883 the civil Health Reports contain several references to outbreaks of fever, not enteric, amongst the civil population, but in the two years following the house disconnection febrile diseases are stated to be not so prevalent as formerly. There are, however, no figures in the Health Reports to support these general statements.

Examination of Goats.

Twenty years ago goats were allowed to graze on the upper portions of the western side of the Rock, and for this purpose passes were granted to goat-keepers by the Royal Engineers. On consulting the records in the office of the War Office Lands, it appears that in the year 1883 passes for 1,795 goats were granted. During the year 252 goats were sold; consequently, in 1884, there were 1,543 goats on the Rock. In 1886 the Royal Engineer records showed passes granted for 1,512 goats. In 1887 only 1,285 passes were given, and these were reduced to 1,104 in 1888. In 1890 the passes were reduced to 590, and in 1892 some 80 of these were cancelled. In 1893 the War Office took possession of the ground below Ince's Farm and 150 goats kept there at the time were sold. From 1894 to 1902 the number of goats appears to have changed very little. An examination made by Sanitary Inspector Balestreno at the end of 1903 showed 413 goats to be present. In 1904 the passes were reduced to 210, and when I commenced the examination of goats in 1905 I found 254 goats distributed on the various parts of the Rock.

It might be urged that though passes for grazing were withdrawn, the goats were still kept and fed in the goat-sheds. This, however, was not the case, as from information supplied by former goat-keepers, who no longer follow the trade, I have ascertained that from 1883 to 1893 about 1,100 goats were sold. As many Maltese goat-keepers who used to keep goats have left the Rock, it is not possible to trace the fate of all the goats present in Gibraltar in 1883. Still, as the Maltese now following the goat trade assure me that goats were not kept in any numbers when passes for grazing could not be obtained, and as the War Office took over the land upon which many of the old goat-sheds were built, I think the figures given above may be taken as representing fairly accurately the number of goats on the Rock during the years mentioned.

It is interesting to note that in 1883 practically all the goats on the Rock were Maltese, and at that time regular shipments of goats from Malta to Gibraltar took place. *Pari passu* with the withdrawal of grazing passes and the increase in the cost of shipment, the importation of goats from Malta on a large scale ceased, and goat-keepers replaced their stock partly by importation of Spanish goats and partly by breeding. In this way three classes of goats were obtained, viz.: (1) Spanish goats; (2) Maltese goats, descendants of the goats originally brought from Malta; (3) "mixed" goats, obtained mainly by breeding from Maltese fathers and Spanish mothers.

Infection of Goats Existing on the Rock in 1905.—Specimens of blood were taken from 254 goats found on various parts of the Rock and tested in the usual manner with a recent culture of the *Micrococcus*

melitensis, dilutions of serum from 1 in 10 to 1 in 100 being made. The results obtained are given in the attached table, which shows that 14 per cent. of the goats gave a reaction with the *Micrococcus melitensis*. There appears to be very little difference between the infection (about 15 per cent.) of the Maltese and "mixed" breeds. Of the Spanish goats, however, only 11 per cent. seem to be infected. Samples of milk were taken from all the goats, except those that were pregnant, and tested for agglutination. The milk from Nos. 3 and 4, both Maltese goats, in Goat-shed No. 1, Engineer Road, caused immediate clumping of a rich emulsion of the *Micrococcus melitensis*. None of the other samples of milk, whether from infected or non-infected goats, gave any signs of a reaction. Ten cubic centimetres of each sample of milk were then centrifugalised and the deposit plated on glucose-nutrose-litmus-agar. Numerous colonies of the *Micrococcus melitensis* were found in the plates made with the milk from the Maltese Goat No. 4, Engineer Road. It was expected that the specific organism would also be found in the milk of Goat No. 3, Engineer Road, but though it was repeatedly examined, no signs of the *Micrococcus melitensis* could be detected. Five cubic centimetres of blood were taken from Goat No. 4 on three different occasions and planted out in broth, but no growth occurred. An examination of the milk was made at frequent intervals during the next three months, but the *Micrococcus melitensis* never appeared again; consequently, it would seem that Goat No. 4 had not been recently infected.

It will be noticed that the dilutions of the sera, which reacted with the *Micrococcus melitensis*, are mostly low, only two sera reacting in a dilution of 1 in 100 and six in a dilution of 1 in 50. These reactions also suggest that many of the goats are probably in a late stage of the disease. A re-examination of the goats made six months later proved this to be the case, as the sera, which formerly reacted in dilutions of 1 in 100 and 1 in 50, then only reacted in dilutions of 1 in 20 and 1 in 10, and many of the sera reacting in dilutions of 1 in 20 and 1 in 10 gave no reactions at all.

Further evidence of infection, not of recent date, was also obtained by examining the cows in Mr. Patron's dairy. These cows are kept under exceptionally good sanitary conditions, and though they are stall-fed in Gibraltar, a constant interchange with cows kept at the farm in Spain is kept up. When I commenced the examination there were 12 cows in the dairy and 49 cows at the farm. The serum of one of the cows (Huelfanita) in the dairy, when diluted 1 in 100, caused instantaneous clumping of the *Micrococcus melitensis*. This cow had recently calved, and was in a bad state of health owing to a retained placenta. The first secretion of milk, diluted 1 in 100, was also found to agglutinate the *Micrococcus melitensis*. During the

next 14 days 30 c.c. of the milk were centrifugalised daily and the deposit plated. The *Micrococcus melitensis* was never recovered. A week later the cow died, and at the *post-mortem* examination the spleen was found small and firm in consistence; the glands also were small and fibrous in texture. Cultures were made from the spleen, glands, liver, and kidneys, but no signs of the *Micrococcus melitensis* appeared. From the appearances found at the *post-mortem* examination it is certain that the cow, Huelfanita, had not been recently infected. The cows at the farm were next examined, and the serum taken from one of them, when diluted 1 in 20, was found to react with the *Micrococcus melitensis.*

Mode of Infection of the Goats on the Rock.—It appears probable that infected goats were imported amongst the herds brought from Malta, but the disease now existing cannot have a direct Maltese origin, as very few goats belonging to the imported stock now remain, and none of these are infected. It might be suggested that many of the goats now on the Rock are not really infected, and that the serum reactions given by the descendants of the old stock are due to agglutinations transmitted *in utero* from infected parents. In the last report of the Mediterranean Fever Commission it was shown that agglutinins are sometimes transmitted from an infected mother to the kid. The transmission of agglutinins was also noticed in the case of several kids born of infected mothers in Gibraltar, and the serum of the calf of the cow, Huelfanita, mentioned above, was also found to agglutinate the *Micrococcus melitensis.* But as these agglutinins did not persist for more than six weeks, and the serum reactions given in the table were found little changed at the end of three months, it is not likely that they were caused by agglutinins transmitted from infected mothers, and the goats must be considered really infected.

The transmission of the *Micrococcus melitensis* from mother to kid could not be demonstrated in Malta, and in Gibraltar two apparently infected kids were killed immediately after birth, and cultures were made from the organs. Though more than 80 cultures were made not a sign of the *Micrococcus melitensis* could be discovered. It is evident, therefore, that the disease now existing amongst the goats must have been acquired on the Rock. In previous reports I have shown that the *Micrococcus melitensis* is excreted in the urine of goats, and that healthy goats can be infected by food contaminated with urine containing the specific microbe. The evidence obtained from a study of the goats in the shed at Palace Gully Steps strongly supports the idea that this is a mode of infection now operating amongst the goats on the Rock. The goats were first examined at the end of October, 1905, and five goats were found to be infected. At the end of March, 1906, the herd was re-examined, when five other goats, which were found perfectly healthy at the first examination,

showed a blood reaction, and from the milk of one of these goats the *Micrococcus melitensis* was isolated. The goats became infected during the winter months, when biting flies and mosquitoes were not to be found.

I noticed, however, that the coats of the goats were infested with pediculi, and as many of these were full of blood, I thought they might possibly act as a means of conveying infection. Accordingly, specimens full of blood were taken from infected goats and thoroughly washed with water, the thorax and abdomen were then opened with a sharp curved bistoury, and the blood and viscera were transferred to a sterile glass slide. A little sterile salt solution was then added, and the blood and viscera having been thoroughly mixed with it, the mixture was drawn up in a capillary pipette and then plated on glucose-litmus-nutrose-agar. More than 150 pediculi were examined in this manner, but no signs of the *Micrococcus melitenis* were discovered.

The goats in the shed at Palace Gully Steps, during the winter months, were under the same conditions as the contact experiments, related in the Fourth Report, in which diseased and healthy monkeys were allowed full contact, mosquitoes and flies being excluded by mosquito netting. Under the conditions described, healthy monkeys became infected by associating with diseased monkeys, and the infection could only be attributed to micrococci contained in the urine of the infected monkeys. Other sources of infection being excluded, it appears certain that goats during the winter months may become infected in this manner.

During the summer months it is possible, as I stated in the Fourth Report, that goats and cows may be infected by mosquitoes which have fed on infected men and animals; but of this mode of infection I could not obtain any evidence. In one shed, during the summer months, a healthy herd of goats was only separated by a wooden partition from diseased goats, but no infection of the healthy goats occurred, though *Culex pipiens* and *Stegomyia fasciata*, which have been shown to act as carriers of the *Micrococcus melitensis*, are found abundantly on the Rock. This result I attributed to the facts that there were no cases of Mediterranean Fever amongst human beings in the vicinity of the goat-sheds, and that the infected goats were in a chronic state of the disease, no evidence of the presence of the *Micrococcus melitensis* in their blood or milk being obtainable at the time.

The evidence of disease amongst the Spanish goats in Gibraltar was very interesting, and raised the question whether goats living on the hills and in the towns in Spain are infected. The Spanish goats living on the Rock were always associated with goats of the Maltese and "mixed" breeds, so they might easily have become infected in the manner just described. But as goat-keepers are now introducing

Situation of goat-shed.	Number of goats. Spanish (S.).	Maltese (✢).	Mixed (M.).	Total.	Number of infected goats. Spanish.	Maltese.	Mixed.	Total.	Infected goats. Age.	Place of birth.	Dilution of serum reacting with *M. melitensis*. 1/10.	1/20.	1/50.	1/100.
									years.					
Palace Gully Steps...	13	19	5	37	0	3	2	5	(1) M. 2	Gibraltar	+	+	+	+
									(2) M. 2	,,	+	0	0	0
									(3) ✢ 1	,,	+	+	0	0
									(4) ✢ 4	,,	+	+	+	0
									(5) ✢ 6	,,	+	0	0	0
Lime Kiln Gully......	1	1	13	15	0	0	5	5	(1) M. 6	Gibraltar	+	+	0	0
									(2) M. 2	,,	+	+	0	0
									(3) M. 2	,,	+	0	0	0
									(4) M. $1\frac{8}{12}$	,,	+	0	0	0
									(5) M. 4	,,	+	0	0	0
Engineer Road, Goat-shed No. 1 (F. F.)	1	29	1	31	0	5	1	6	(1) ✢ 3	Gibraltar	+	0	0	0
									(2) ✢ 5	,,	+	+	+	0
									(3) ✢ 2	,,	+	+	+	+
									*(4) ✢ 3	,,	±	0	0	0
									(5) ✢ 2	,,	+	0	0	0
									(6) M. 3	,,	+	0	0	0
Engineer Road, Goat-shed No. 2 (T. D.)	10	13	0	23	0	3	0	3	(1) ✢ 3	Gibraltar	+	0	0	0
									(2) ✢ 2	,,	+	0	0	0
									(3) ✢ 2	,,	+	0	0	0
Engineer Road, Goat-shed No. 3 (T. V.)	8	0	29	37	0	0	0	0	—	—	—	—	—	—

Engineer Road, Goat-shed No. 4 (A. C.)	8	1	10	19	3	0	1	4	(1) S. (on the Rock $2\frac{3}{12}$ years)	Spain	+	0	0	0
									(2) S. (do., 3 years)	,,	+	0	0	0
									(3) S. (do., 4 ,,)	,,	+	0	0	0
									(4) M., age 4 ,,	Gibraltar	+	0	0	0
Naval Hospital Hill...	5	8	15	28	1	1	3	5	(1) S. (on the Rock 6 years)	Spain	+	+	0	0
									(2) M., age 4 years	Gibraltar	+	0	0	0
									(3) M., ,, $1\frac{2}{12}$,,	,,	+	0	0	0
									(4) M., ,, 4 ,,	,,	+	0	0	0
									(5) ✝, ,, 5 ,,	,,	+	0	0	0
Rosia....................	10	8	21	39	3	2	3	8	(1) S. (on the Rock 2 years)	Spain	+	0	0	0
									(2) S. (do., 6 years)	,,	+	+	0	0
									(3) S. (do., 4 ,,)	,,	+	+	+	0
									(4) ✝, age 3 years	Gibraltar	+	0	0	0
									(5) ✝, ,, $2\frac{6}{12}$,,	,,	+	+	+	0
									(6) M., ,, 3 ,,	,,	+	0	0	0
									(7) M., ,, $1\frac{8}{12}$,,	,,	+	0	0	0
									(8) M., ,, $1\frac{8}{12}$,,	,,	+	0	0	0
Catlan Bay	0	9	7	16	0	0	0	0	—	—	—	—	—	—
Almeda	6	2	1	9	0	0	0	0	—	—	—	—	—	—
Total	62	90	102	254	7	14	15	36	—	—	—	—	—	—

* *Note.*—The *M. melitensis* was recovered from the milk of No. (4).

Spanish goats to replace the Maltese, it was of great importance to find out whether those entering the Fortress showed any signs of disease. With this object in view, I examined a herd of 50 goats living in sheds on the hills 10 miles from Gibraltar. The goats were all pure Spanish breed and, so far as I could ascertain, had never been associated with Maltese goats or lived in the neighbouring towns.

Specimens of blood were taken from the goats and examined in the usual manner, but no serum reactions with the *Micrococcus melitensis* were obtained; all the goats appeared perfectly healthy. Different results, however, were obtained when I examined goats which had lived in the Spanish towns of Malaga and Linea. The goat-keepers informed me that the goats they were then importing came from Malaga, and I was led to suspect that these goats might be infected, as I had learnt that when the great exodus of goats from the Rock occurred, many of them were taken to Linea and Malaga as well as to Oran, Algiers, Tangier, and other towns on the African coast. The appearance of some of the goats arriving from Malaga also suggested an admixture of Maltese and Spanish breeds.

Just after I had examined the Spanish country goats, a small herd of 16 goats was brought from Malaga, and, after living in Linea for three months, was allowed to enter the Fortress. I immediately visited the herd and found that while 10 were obviously pure Spanish goats, six showed distinct evidence of a Maltese strain. Samples of blood were taken and the sera were tested in the usual manner. Two of the Spanish goats gave reactions when the sera were diluted 1 in 10, and two of the mixed breed also gave a reaction, one with the serum diluted 1 in 50 and the other with the serum diluted 1 in 10. Samples of milk were then obtained, and 10 c.c. of each having been centrifugalised, the deposit was plated in the usual manner. Each sample of milk was also tested as to its agglutinating action on the *Micrococcus melitensis*. The results were uniformly negative; no signs of the specific microbe were observed in the plates and the milk had no agglutinating power. The goats in this small herd were previously in much the same condition as many of the goats now living on the Rock, notably those found in the shed at Palace Gully Steps.

At the first examination the milk of the infected goats in the shed did not contain the specific microbe, and had no agglutinating action, and yet other healthy goats associating with them became infected. Consequently, the admission of goats from towns in Spain cannot be considered free from danger, and in the interests of the public health it is plain that all goats brought to Gibraltar should be quarantined until examinations of the blood have shown them to be free from infection.

Conclusion.

It appears probable that the rapid disappearance of Mediterranean Fever from Gibraltar, which commenced in 1885, was intimately associated with the exodus of infected goats from the Rock. Improved sanitary conditions, especially the disconnection of waste-pipes and house-drains from sewers, may have played a part in causing the decrease of fever, but as the same sanitary improvements have been carried out in Malta without any corresponding decline of Mediterranean Fever, it is fair to assume that their effect was insignificant compared with that produced by the removal of infected goats.

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VI. BIBLIOGRAPHY OF MEDITERRANEAN FEVER.

1897 to 1907.

Compiled by J. W. H. Eyre, M.D., Referee for Volume R (Bacteriology) of the International Catalogue of Scientific Literature.

The late Surgeon-Captain Louis Hughes included a comprehensive bibliography of Mediterranean Fever, ranging in point of time from the *Epidemics* of Hippocrates (460 to 357 B.C.) to the date of publication, in his own monograph on the subject, which was entitled "Undulant, Malta, or Mediterranean Fever" (Macmillan and Co., 1897). In this work the bibliography occupies the position of an appendix to Chapter I (pp. 29 to 34).

In the compilation of his list—a work in which he had the advantage of Professor Zammit's assistance—Hughes searched through many rare and some unique volumes, both in manuscript and in type, lodged in the Bibliotheca at Valetta, and so secured many valuable references not elsewhere obtainable.

The present list is a continuation of Hughes' bibliography, and embraces the period from the year 1897 to the present date—January, 1907. In it the arrangement of the papers bearing on the subject, which Hughes adopted, viz., grouping together such as appeared in the same year, has been followed, so that continuity is secured; but, as during the past few years the papers on Mediterranean Fever have, in the main, been written by a few observers, the references are also arranged in a separate section in alphabetical order under their respective author's names, in such a manner as to admit of their utilisation for the purposes of a card index, and corrections or additions to this list will be gratefully received by its compiler. The details relating to each reference are arranged according to the plan adopted by the International Catalogue of Scientific Literature,* to the Central Bureau of which—through its Director, Dr. Forster Morley—and particularly to the Regional Bureaus of Germany, Greece, and Italy, the writer wishes to express his thanks for the valuable assistance he has received in the preparation of this list; as well as to the many correspondents whose cordial help has been highly appreciated.

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REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART VI.

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APRIL, 1907.

CONTENTS.

I. REPORT UPON THE BACTERIOLOGICAL AND EXPERIMENTAL INVESTIGATIONS DURING THE SUMMER OF 1906.

By J. W. H. Eyre, M.D., F.R.S. Edin., Bacteriologist to Guy's Hospital and Lecturer on Bacteriology in the Guy's Medical School; Major J. G. McNaught, M.D., R.A.M.C.; Captain J. C. Kennedy, M.B., R.A.M.C.; and T. Zammit, M.D., Government Analyst, Malta, and Professor of Chemistry, Malta University.

SYNOPSIS OF CONTENTS.

PRELIMINARY NOTES ON METHODS.

A brief summary of the technique employed for the isolation and identification of *M. melitensis*, the performance of the agglutination test, and the selection of experimental animals, is inserted here in order to avoid unnecessary repetition in the body of the Report.

Isolation of M. melitensis.

1. *Medium.*—Nutrient peptone broth, prepared from Brand's Essence of Beef and standardised to +10 (Eyre's scale), was frequently used for the preliminary enrichment of blood, etc., but the medium generally employed for the isolation of *M. melitensis*, and except where otherwise stated, was a nutrose-litmus-agar prepared on a basis of peptone broth, containing nutrose to the extent of about 1 per cent., tinted with litmus solution to an arbitrarily chosen colour standard, and standardised so far as concerns reaction to +10 (Eyre's scale).

This was the medium employed by the members of the Commission during the years 1904 and 1905; and although by no means the optimum medium, it was decided to continue its use throughout 1906 in order to render the results absolutely comparable with those of former workers.

2. *Method of Culture.*—This medium was used in the form of surface "plates"—the liquefied agar being poured into Petri dishes, allowed to "set," and, as a preliminary to inoculation, incubated for 24 hours at 37° C., so that any accidentally contaminated plates might be detected and discarded. In preparing plates, the infected material was deposited near the centre of the surface of the nutrose-agar and then distributed over the entire surface of the medium by the aid of a sterile L-shaped glass spreader. In the case of grossly-contaminated material, several plates were prepared *in series*—that is to say, after the first plate had been inseminated the same spreader was employed to inoculate a second, then a third, and even a fourth and fifth with the traces of infective material still adhering to it—a method which yields dilutions comparable to those prepared by measuring with loopfuls when the liquefied medium in tubes is inoculated and then used for pouring plates.

Incubation was invariably carried out aerobically at 37° C., and in those cases where colonies of *M. melitensis* had not developed by the second or third day, all plates were studied for at least seven days —except where the plates were so grossly contaminated as to be unworkable.

Identification of M. melitensis.

Suspicious colonies of cocci developing on these plates were first tested with serum derived either from patients suffering from Malta Fever or from experimental animals, in dilution of, usually, 1 in 100. Such as responded to this test and yielded a positive agglutination reaction were sub-cultivated in tubes of ordinary agar (+10), and the subsequent growths, before being recorded as due to *M. melitensis*, were required to conform to the following criteria:—

1. Size, shape, and Brownian activity
2. Readiness and homogeneity of emulsion

} Corresponding to those exhibited by authentic type cultures.

3. Non-retention of stain when treated by Gram's method.
4. Production of alkaline reaction without change of consistency in litmus milk.
5. Complete clumping when tested with specific agglutinating serum in high dilution: the dilution varied with the maximum titre of the serum employed, but was usually 1 in 1000.

In many cases the cocci under examination were further tested as to their ability to produce *M. melitensis septicæmia* in the guinea-pig when inoculated intracerebrally.

Performance of Agglutination Reactions.

The culture employed was invariably an early sub-culture grown on ordinary +10 agar in "sloped" tubes and usually for 24 or 48 hours

at 37° C., from a strain of *M. melitensis* that had recently been isolated from the animal body. Occasionally, but very rarely, it was found necessary to use three-day-old cultures, but the use of such old cultures was discouraged as much as possible.

The growth was emulsified in sterile 0·1 per cent. salt solution or in sterile distilled water, in the proportion approximately of 0·5 milligramme of bacterial growth to 1 c.c. of fluid.

The serum to be tested was diluted with normal saline solution and deposited in a series of small test-tubes. The dilutions prepared started with 1 in 5 (20 per cent.), and 1 in 10 (10 per cent.), and proceeded upwards in tenths of the first named—*e.g.*, 1 in 50 (2 per cent.), 1 in 500 (0·2 per cent.), and so on, so that when equal quantities of emulsion and diluted serum were mixed, dilutions of 1 in 10, 1 in 20, 1 in 100, 1 in 1000, etc., were available for examination, other secondary dilutions, 1 in 50, 1 in 200, etc., being prepared and examined as occasion required.

The examination was carried out both microscopically in the hanging drop, and macroscopically in sealed Pasteur pipettes—each method of observation being carefully controlled by a blank preparation consisting of equal quantities of normal salt solution and emulsion of *M. melitensis*.

In the microscopical examination, the period of observation was limited to 30 minutes, and the result recorded as positive (+) when *all* the cocci were agglutinated into large clumps and none remained free in the fluid; as incomplete (±) when the clumps were small, and many cocci, singly and in pairs, were scattered about the field; and as negative (−) when clumps were very small, comprising only a dozen or so individual cocci, or were completely absent.

In the macroscopical examination, the period of observation was extended, if necessary, to 24 hours, and a positive result recorded only when the supernatant fluid was quite clear and all the cocci had sedimented into a compact mass at the point of the pipette; a loose mass of cocci below and slightly turbid fluid above was returned as an incomplete reaction, and where the contents of the pipette closely resembled those of the control a negative reaction was recorded. In only a very few of the many thousands of preparations put up during the course of the summer did the macroscopical and microscopical results fail to control and confirm each other.

Selection of Animals for Experimental Work.

Healthy animals, such as goats, kids, and monkeys, after purchase, were placed in the Lazzaretto as soon as they reached the Commission. Here they were tethered—out of reach of each other in the various stables and rooms which had been rendered fly- and mosquito-proof by

covering the windows with fine gauze and supplying the doorways with mosquito-netting curtains—away from either infected animals or healthy animals already stabled there. The rectal temperature was taken night and morning; the blood repeatedly examined for the presence of specific agglutinins, and, in the case of milch goats, the milk examined for the presence of the *M. melitensis*. Only when the temperature showed an absence of marked excursions from the accepted normal, and no evidence of infection with *M. melitensis* could be detected, were the animals regarded as "healthy and normal," and as such used for the experimental work of the Commission.

I.—The Goat as a Factor in the Dissemination of Mediterranean Fever.

1. *The Distribution of Milch Goats Naturally Infected with* M. melitensis.

The work of the previous year in collecting information respecting the distribution of infected goats by examining herds from various parts of the island was continued as opportunity afforded in 1906. In the first place, the milk supply of various military centres and the village of Lia were investigated with the following results :—

Table I.—The Proportion of Healthy and Infected Milch Goats in various Herds.

Herd supplying.	No. of goats in herd.	Milk reaction in	*M. melitensis* in milk of
1st Rifle Brigade	46	7	1
West Kent Regiment	40	10	3
(Re-examination of reacting goats)...		(3)	(0)
Citta Vecchia Sanatorium*	38	12	3
Forrest Hospital†	8	0	0
Imtarfa Hospital	60	2	0
Valletta Hospital‡........................	18	6	1
Lia	85	8	0
Total	295	45	8
Percentage	...	15·2	2·7
* The corresponding figures for 1905 were	15	11	5
† " " "	15	5	1
‡ " " "	13	4	1

The small number of goats (18 animals) examined in connection with Valletta Hospital comprised only about one-quarter of the

goats actually supplying milk to the hospital, but the passive resistance of the goatherds in relation to the collection of samples, which was in no way overcome by the loud protestations of the contractor, resulted in the absence of the remainder of the goats whenever an attempt was made to collect specimens of milk. Within a few days of the examination of this small portion of the herd a general strike of the goatherds supplying milk to Valletta was instituted and maintained from May 14th until June 1st, 1906. The strike lasted, in fact, until all the military hospitals and the majority of other large consumers had been compelled to replace their supplies of goats' milk by various brands of condensed or other tinned milk. Having thus forfeited their contracts and being no longer in the position of supplying milk to the hospitals and regiments, all hold over the goatherds was lost, and it was subsequently found to be impossible to complete these examinations in which a portion only of a herd had been investigated.

A comparison with the results obtained in 1905* shows that the average number of infected animals, per herd, was much smaller than that noted when large numbers distributed over more extensive areas were dealt with, and forcibly illustrates the fallacy which would attend generalisations from the results obtained above.

At the commencement of the season's work when comparing the incidence of Malta Fever upon the civil population of the island in the various local centres, the severity of this incidence upon certain villages, and the apparent absence of the disease from others closely adjacent, was particularly noticeable, and it was decided to carefully investigate the milk supply of Rabato, a suburb of Citta Vecchia, and to remove from time to time such goats as were found to be discharging *M. melitensis* in their milk from the herds examined, and study the effects of the removal of so much infective material from a restricted area upon the incidence of the fever.

This plan was at once put into execution, and a preliminary examination of the Rabato herds gave the following results:—

Table II.—Infected Goats at Rabato.

No. of herds examined.	No. of goats examined.	No. of milks reacting.	No. of milks containing *M. melitensis*.
49	342	52	16
	Percentage......	15	4·6

* *Vide* Zammit, these Reports, IV, 96 *et seq.*; Horrocks and Kennedy, IV, p. 87 *et seq.*

At first all went well. Samples were readily supplied, and the 16 infected goats were handed over by their owners for observation and treatment at the Lazzaretto, where each was supplied with a collar bearing a metal disc on which was stamped a serial number, to aid in the ready identification of the individual goats. The serial numbers commenced at 101 in order to avoid any confusion with experimental and other goats remaining at the Lazzaretto from previous years. (These animals were subsequently purchased at valuation and were utilised for experimental observations throughout the summer.) Soon, however, the influence of the goatherds' strike in Valletta spread to the provincial districts, and the goatherds of those villages in which operations were being carried on, refused in their turn to allow milk samples to be taken.

Unfortunately, the local ordinances and statutes regulating the supply of food stuffs take little active cognisance of the goat as a source of milk, and proved totally inadequate—at any rate from a diplomatic standpoint—to enforce compliance with the requests of members of the Working Party even when supported by sanitary inspectors, and the observations had perforce to be abandoned. The details of the examinations that were carried out are, however, inserted in Table III, because from them, incomplete though they are, emerge one or two suggestive points of more than passing interest.

A subsidiary matter was to have been the investigation of those milch goats which, by the presence of specific agglutinins in their body fluids, gave evidence of infection, recent or remote, by *M. melitensis*, but whose milk did not contain the micro-organism. It was hoped that by a careful study of these animals some criteria might be arrived at by which it would be possible to determine whether the infection was so remote that the milk would remain innocuous, or so recent that the appearance of *M. melitensis* in the milk would be an ever-present danger.

This investigation likewise had to be temporarily abandoned with the larger experiment.

During the course of the investigations, perhaps the most striking observation recorded was the healthy appearance of the majority of the infected goats. The animals were sleek and plump, with smooth, healthy-looking coats; they took their food well, were as active as their uninfected fellows, and yielded as large a quantity of milk and of apparently as good a quality. Palpation failed to reveal any enlargement of lymphatic glands or of alteration of the mammary gland. In many instances the infected milch goats were the best looking and the best milkers in the herd, and in a few instances only it was noted that an infected animal suffered from a short barking cough at infrequent intervals.

Perhaps the most noteworthy feature in the following table is the

Table III.—Examination of Herds at Rabato.

No. of herd.	Name of owner.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis.*	Cases of Malta Fever on the premises during the current 12 months.
1	F. Vassallo	2	0	—	—
2	M. Borg	2	0	—	—
3	P. Cutajar	15	0	—	—
4	G. Mifsud	3	0	—	—
5	G. Agius	24	9	4	1
6	A. Micallef	4	0	—	—
7	G. Vassallo	5	0	—	—
8	P. D'Anatas	3	0	—	—
9	G. Ciantar	4	0	—	—
10	G. Attard	2	0	—	—
11	S. Micallef	7	2	1	1
12	L. Micallef	4	0	—	—
13	G. Galea	6	2	1	1
14	G. Azzopardi	5	3	2	2
15	L. Sant	11	4	—	1
16	G. Attard	8	2	—	1
17	F. Micallef	5	0	—	—
18	P. Sant	22	6	—	1
19	G. Grech	9	0	—	—
20	G. Inguanez	5	0	—	—
21	G. Micallef	8	0	—	—
22	P. Micallef	2	0	—	—
23	F. Galea	14	1	—	—
24	G. M Azzopardi	7	1	—	—
25	S. Pace	12	0	—	—
26	C. Formosa	13	0	—	1
27	G. Micallef	4	1	—	1
28	V. Azzopardi	7	1	—	—
29	G. Vassallo	2	0	—	—
30	P. Borg	4	1	—	—
31	C. Borg	2	0	—	—
32	G. Micallef	1	0	—	—
33	G. Azzopardi	12	0	—	—
34	A. Dimech	5	0	—	—
35	F. Micallef	4	0	—	—
36	P. Borg	1	0	—	—
37	A. Dimech	1	0	—	—
38	V. Borg	17	10	7	2
39	C. Borg	29	2	—	—
40	Carmela Mifsud	9	4	1	*
41	G. Zabra	14	4	1	5
42	F. Vassallo	5	0	—	—
43	F. Portelli	2	0	—	—
44	S. Camilleri	2	0	—	—
45	C. Calleja	3	0	—	—
46	V. Attard	5	0	—	1
47	P. Formosa	9	1	—	—
48	C. Mifsud	4	0	—	—
49	S. Dingli	2	0	—	—

* In close association with next-door neighbour and relative (G. Zahra), owner of Herd No. 41, in whose house five cases have occurred.

occurrence of one or more cases of Malta Fever during the present twelvemonth in the household of every owner of a milch goat, which, by reason of the isolation of the *M. melitensis* from its milk, was conclusively proved to be infected, with one exception, viz., in the case of Herd No. 40, whose owner occupied the adjoining house to the owner of Herd No. 41. Here the two families and the two herds were intimately acquainted and in close daily contact, and in the house of the owner of Herd No. 41 no less than five cases of Malta Fever have occurred.

This association of cases of Malta Fever in man with infected milch goats suggests in a striking manner the highly infective character of the milk cultivation—usually practically pure—of *M. melitensis* yielded by many of these milch goats, for the Maltese goatherd keeps his goats for profit and rarely uses goat's milk as a food for himself or his family; and we are, personally, convinced from our enquiries and observations that, in the vast majority of cases occurring in goatherds and their families, infection is contracted during the handling of this food by the direct inoculation of infected milk into cuts, scratches and abrasions on the face, hands, forearms, feet and legs of the individual.

Cases were also present in some of the households where the herds contained milch goats, which, although yielding a positive agglutination reaction at the time of examination, were not passing the micro-organism in the milk. This, however, is no matter for surprise, and in no way militates against the views expressed above, for, as it will be mentioned later, it is not uncommon for a milch goat to yield milk one day containing more than 30,000 *M. melitensis* per cubic centimetre, and a few days later, milk apparently quite free from the microbe.

It has already been stated that many of these herds at Rabato were examined more than once, some a second time three weeks after the preliminary examination, and a few on a third occasion a fortnight later, before the milk vendors' strike became general. These re-examinations and their results are set out in Tables IV and V.

Inspection of these tables shows also the variation in size that individual herds undergo during comparatively short periods, in the present instances quite apart from the diminution in numbers resulting from the removal of those goats whose milk yielded *M. melitensis* from their respective herds to the experimental stables at the Lazzaretto.

The figures quoted were obtained by actual observation and by comparison with the Registration Books kept at the local police headquarters; for a system is in vogue under which every goat owner reports, personally or by proxy, the number of goats in his possession every Saturday to the police. The number thus reported includes kids, male goats, and pregnant females not yielding milk as well as milch goats in full milk, the object of registration being to assist the Sanitary Service in the event of the occurrence of an epidemic of foot-and-mouth disease, by calling attention to any diminution in the number of

Table IV.—Re-Examination of certain Herds at Rabato.

No. of herd.	No. of examination.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis.*
3	First	15	0	0
	Second	10	0	0
4	First	3	0	0
	Second	3	0	0
5	First	24	9	4
	Second	15	5	1
6	First	4	0	0
	Second	3	0	0
15	First	11	4	0
	Second	11	0	0
16	First	7	1	0
	Second	8	1	1
17	First	5	0	0
	Second	5	0	0
19	First	9	0	0
	Second	6	0	0
20	First	5	0	0
	Second	2	0	0
21	First	8	2	0
	Second	7	1	0
22	First	2	0	0
	Second	2	0	0
23	First	14	1	0
	Second	8	0	0
24	First	7	1	0
	Second	5	0	0
25	First	12	0	0
	Second	12	0	0
27	First	4	1	0
	Second	4	0	0
28	First	7	0	0
	Second	7	1	0
29	First	2	0	0
	Second	2	0	0
30	First	4	1	0
	Second	5	0	0
33	First	11	0	0
	Second	10	0	0
40	First	9	4	1
	Second	6	1	0
41	First	14	4	1
	Second	10	1	0
45	First	3	0	0
	Second	2	0	0
46	First	4	0	0
	Second	4	0	0
48	First	4	0	0
	Second	4	0	0

animals comprised in each herd. In practice, during the absence, as now, of epidemic foot-and-mouth disease, the system is useless, but the machinery at present in existence can undoubtedly be readily utilised

for that efficient system of registration of milch goats that the Local Government will be compelled to enforce if it seriously desires to stamp out Malta Fever from the island.

Table V.—Third Examination of Certain Herds at Rabato.

No. of herd.	No. of examination.	No. of goats in herd.	No. of milks reacting.	No. of milks containing *M. melitensis*.
	First	5	3	2
14	Second.........	3	1	0
	Third	5	0	0
	First	21	6	0
18	Second.........	21	0	0
	Third	21	2	1
	First	4	0	0
35	Second.........	4	0	0
	Third	4	0	0
	First	9	1	0
47	Second.........	11	0	0
	Third	11	0	0

A further point, and one of considerable practical importance, depends upon the inconsistent results obtained at succeeding examinations, and is brought out in Table V. Taking the herds in order, at the first examination of Herd No. 14, which comprised five milch goats, the milk from three was found to give an agglutination reaction, and from two of these the micrococcus was recovered. These last two animals were removed to the Lazzaretto. At the next examination of the three remaining animals the one that had previously given a positive agglutination reaction still reacted, but the milk did not contain the coccus. At the third examination the owner had added two more milch goats, and none of the five reacted, that is to say, the reaction had disappeared from the animal that had reacted on two previous occasions.

Herd No. 18 consisted of 21 goats, including six whose milk gave a positive reaction. At the second examination none of these six reacted, while at the third examination two of those which had previously reacted again showed the reaction, and the milk of one of them now contained the specific coccus.

Herd No. 35 consisted of four healthy milch goats, none of which showed any sign of infection at the subsequent examinations.

Herd No. 47 consisted at first of nine goats, and the milk from one of them gave a positive agglutination reaction at the first examination, but a negative reaction at the second and third examinations. Subsequently the owner added two healthy animals to his herd.

These results show conclusively the necessity for repeated examina-

tions at short intervals of every herd if the detection of *all* the infective animals is aimed at.

2. *The Agglutination Test as Applied to the Milch Goat.*

The possibility that the Government of Malta might at some future period, should the infectivity of goats' milk be conclusively established, legislate on the subject, was fully appreciated in planning the observations on the milk supply of Rabato, and methods of examination were carefully investigated with a view to simplifying and systematising the routine analyses of milk that would have to be undertaken by the Public Health Department in such a contingency.

In the first place, there is no evidence that the ingestion of specific agglutinins with the milk is, *per se*, injurious to health, and the legislature would undoubtedly require the recognition of the *M. melitensis* itself in the milk as proof that such milk was noxious in character; and as in the administration of any regulation dealing with milk the frequent examination of a large number of animals would have to be undertaken, it became necessary to determine the simplest, most rapid, and most reliable method of sorting out the animals which were most likely to be passing the micrococcus in their milk before proceeding to attempt the isolation of the micro-organism by bacteriological methods.

Such a method already existed in the milk agglutination test devised by Zammit and bearing his name, a test which depends upon the fact that *M. melitensis* agglutinins, like other specific agglutinins and antibodies when present in the body in sufficient quantity, pass into the milk, and to a less extent into the urine, and can be readily demonstrated in these situations. This test, it must be stated, has limitations which form its strong feature for the purpose with which we are at present concerned.

The work carried out by the Commission in 1905 showed clearly that in presumably very remote or in very recent infections the presence of agglutinins could not be demonstrated in the milk, although they were present in the blood in sufficient quantity to yield a positive reaction in low dilutions when the blood serum was tested. On the other hand—and this is the point of practical importance—*M. melitensis* has never yet been isolated, in the present series of experiments, from a sample of milk from which the specific agglutinin was absent.

In its elemental form the test under consideration consists primarily of the admixture of equal parts of the suspected milk and an emulsion of *M. melitensis* in normal saline solution. As originally devised, it was completed in one of two ways, either by making a hanging drop preparation of the mixture and observing it microscopically after the lapse of 12 hours, or by running the mixture into capillary tubes or

sedimentation pipettes, and observing macroscopically after a similar period.

A reference to a previous part of these Reports (IV, pp. 55 and 97—98) will show that a difference of opinion existed as to the best method of performing the test, some observers preferring the hanging-drop method, others the tube method. In point of fact, both had many disadvantages.

In the microscopical method, quite apart from the difficulty of entirely preventing evaporation when the period of observation continued for so long a time as 12 hours, the difficulties introduced by the presence of masses of varying sized oil globules, which obscured all but the very large clumps, were considerable, and in the event of observations being made by partially-trained observers would undoubtedly lead to inaccurate results. These considerations early led to the rejection of this form of the test as a practical measure.

The macroscopical method was next studied, and as the perfect emulsification of the fat which obtains in goats' milk was undoubtedly the cause of the disfavour with which the test was received, a low dilution of 1 : 3 was first employed. In this series of tests numerous observations were made, carefully checking the naked eye results by running the deposit out of the capillary tube or sedimentation pipette and examining it microscopically. It was soon found that when results recorded at five hours were taken this method was a satisfactory and reliable one, but when tubes were left standing overnight the results noted in the morning were as often as not fallacious owing to the formation of a bulky deposit consisting of *débris*, leucocytes, etc., and not of clumps of *M. melitensis*.

Next was tried the effect of first converting the milk into curds and whey by the addition of rennet or of acid, separating off the curds and testing the whey. A number of experiments were made simultaneously with various samples of milk, and with whey prepared from each sample, and it became at once apparent that the agglutinins, unaltered, were present in the whey. The whey reaction was given equally well, was as definite as with clear serum, and obviously no confusion could arise with regard to pseudo reactions, due to the collection of *débris*, so that apart from the extra time and labour involved in preparation, the whey gave eminently satisfactory results.

On subsequently plating, however, it was found that cultivations prepared from whey yielded only about 10 per cent. of the number of micrococci developing from the corresponding milk sample after an identical period of incubation, a result possibly due to retention of cocci in the curd, possibly to destruction of cocci by acid.

Further dilutions of the milk itself were then tried, and finally it was determined that the most trustworthy and convenient method was to employ a dilution of 1 : 20 in capillary tubes or sedimentation

Table VI.—Comparison of the Agglutination Value of Milk

Date	July, 21, 1906.			July 24, 1906.			July 26, 1906.			July 28, 1906.		
Dilution	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100	1 : 20	1 : 50	1 : 100
Goat 101—												
Milk		0		+	+	—		0		+	—	—
Serum				+	+	+				+	+	+
Goat 102—												
Milk		0		—	—	—		0		+	+	—
Serum				+	+	+				+	—	—
Goat 103—												
Milk		0		—	—	—		0		—	—	—
Serum				+	+	+				+	+	+
Goat 104—												
Milk		0		+	—	—		0		+	—	—
Serum				+	—	—				+	+	+
Goat 105—												
Milk		0		+	+	+		0		+	+	—
Serum				+	+	+				+	—	—
Goat 106—												
Milk		0		+	+	+		0		+	+	—
Serum				—	—	—				—	—	—
Goat 108—												
Milk		0		+	+	—		0		+	—	—
Serum				+	+	+				+	+	+
Goat 110—												
Milk	+	+	±		0		+	—	—		0	
Serum	+	+	+				+	+	+			
Goat 111—												
Milk	+	+	±		0		+	±	±		0	
Serum	+	+	±				+	+	+			
Goat 112—												
Milk	+	+	+		0		+	±	±		0	
Serum	—	—	—				—	—	—			
Goat 113—												
Milk	+	+	+		0		+	+	+		0	
Serum	+	+	+				+	+	—			
Goat 114—												
Milk	+	±	±		0		+	+	±		0	
Serum	+	+	+				+	+	+			
Goat 115—												
Milk	+	+	—		0		+	+	+		0	
Serum	±	±	—				+	—	—			
Goat 117—												
Milk	+	+	—		0		+	+	+		0	
Serum	+	+	—				+	—	—			
Goat 118—												
Milk	+	—	—		0		+	+	—		0	
Serum	+	—	—				+	+	—			
Sheep 107—												
Milk		0		+	+	—		0		+	—	—
Serum				+	+	+				+	+	+

0 = not examined.

and Blood Serum in the Infected Milch Goat and Sheep.

July 31, 1906. 1 : 20	1 : 50	1 : 100	August 2, 1906. 1 : 20	1 : 50	1 : 100	August 4, 1906. 1 : 20	1 : 50	1 : 100	August 7, 1906. 1 : 20	1 : 50	1 : 100
	0		+ +	− +	− +		0		+ +	+ −	− −
	0		÷ +	− +	− −		0		+ −	± −	± −
	0		− +	− +	− −		0		+ +	+ +	− +
	0		+ −	− −	− −		0		± +	± +	− +
	0		+ +	− −	− −		0		+ −	+ −	− −
	0		+ +	+ +	− +		0		+ −	− −	− −
	0		+ +	− +	− +		0		+ +	+ +	+ +
+ +	− +	− +		0		+ +	+ +	+ +		0	
+ +	+ −	± −		0		+ +	+ +	± +		0	
± −	− −	− −		0		+ +	− −	− −		0	
+ +	+ +	+ +		0		+ +	+ +	+ +		0	
+ +	− +	− +		0		+ +	+ +	+ +		0	
+ +	± +	± +		0		+ +	+ +	+ +		0	
+ +	− −	− −		0		+ +	+ +	− +		0	
− +	− +	− +		0		+ +	− −	− −		0	
	0		± +	− +	− −		0		+ +	+ +	+ +

0 = not examined.

pipettes with a time limit of 24 hours—a method carried out in actual practice by mixing equal volumes of a 1 : 10 dilution of milk with the previously prepared emulsion of *M. melitensis* in distilled water. Under these conditions the fluid is sufficiently clear to show the reaction quite as definitely as in the case of blood serum, while the specific gravity is so altered that the fat globules are very quickly disentangled and rise to the upper part of the column of fluid as cream, and the risk of pseudo reactions from sedimentation of *débris* is avoided.

By repeated experiments it was found that where a true reaction was yielded by the low dilution method (1 : 3), a reaction was obtained in 1 : 20 dilution; but on carrying the dilution higher it was found that milks giving a positive reaction in 1 : 3 and in 1 : 20, and which on plating yielded *M. melitensis* in some instances, gave a negative reaction in 1 : 50.

Moreover, it was found that in the case of sheep the low dilution (1 : 3) did not give reliable results owing to the opacity of the milk; whilst with a 1 : 20 dilution consistent and reliable results were obtained.

The test as thus modified has now been in use for many months, and the best criterion of its utility is summed up by the fact that *M. melitensis* has never been isolated from or detected in a sample of milk which yielded a negative reaction.

It was also noted during the course of these experiments as a general, but far from invariable, rule, that those milks which gave a good sedimentation reaction immediately upon mixing with the bacterial emulsion, or within an hour or two, were more likely to yield cultivations of *M. melitensis* on plating than those which required the full 24 hours for the completion of the reaction.

A comparison of the milk agglutination reaction with the blood agglutination reaction of the infected goat naturally formed part of these experiments with the "Zammit test."

The milk and blood samples were collected at the same time, the test applied with the same bacterial emulsion, and identical dilutions of 1 : 20, 1 : 50, and 1 : 100 were employed in each case.

Roughly speaking, the reactions are comparable: on the whole the blood frequently reacts in higher dilutions than the milk, though in some instances the opposite holds good. In two animals (Goats Nos. 106 and 112) the milk reacted in 1 : 20 when agglutinins appeared to be absent from the blood; in a third (Goat No. 103) the converse obtained, the milk did not react in 1 : 20, while the blood did so. No relationship whatever could be deduced between the intensity of the reaction and the numbers of *M. melitensis* present in the milk. A number of these observations are tabulated on pp. 16 and 17.

The table shows, too, in a most marked manner, the periodic

variation in the agglutination value of the serum, the curve of which is closely followed by that of the milk, due no doubt to auto-inoculation or auto-vaccination with living *M. melitensis* taking place in milch goats which are still the subject of a subacute systemic and generalised infection—an explanation which accords well with observed facts, and which is supported by the results of observations made upon milch goats which were under treatment with vaccine prepared from dead cultures of *M. melitensis.*

3. *The Numerical Relationship of* M. melitensis *to the Milk of Infected Goats.*

As it had already been noted that the milk from an infected goat varied greatly from day to day in its potentialities for evil—that is to say, milk which contained many thousands of individual *M. melitensis* per cubic centimetre when examined one day, at the next examination a few days later, or even on the following day, might be apparently free from the micro-organism, and again in a few more days might be crowded with the cocci—systematic observations were commenced to determine, if possible, whether some definite periodic variation, seasonal or otherwise, existed. These observations are as yet incomplete, but the results of nearly four months' work are available, and on account of their interest are inserted here.

The results show that although the excretion of *M. melitensis* in the milk during some stages of the infection is persistent, it is by no means constant or even consistent; nor—premising that all the observations now recorded were carried out during the so-called summer—was it possible to determine any correlation between the temperature curve and the number of cocci excreted in the milk (*vide* Fig. 2, p. 24). The observations which are being continued throughout the winter may, however, afford further information in this connection when completed. The animals affording material for the enquiry were comprised in a herd of 17 milch goats and 1 milch sheep belonging to the Commission and stalled in the Lazzaretto. Twice and often three times a week a specimen of milk was collected from each animal, immediately conveyed to the Laboratory at Valletta, and there plated out. On account of the extreme variation noted in the numbers developing per cubic centimetre from each animal's milk, together with the necessity for examining the milks from a number of animals each day, it was a matter of some difficulty to decide on the amount of milk to be plated for each examination. After many experiments in this direction 0·035 c.c.—an amount equivalent in bulk to a single drop falling by gravity from the end of a fine capillary pipette—was decided upon, and three plates were inseminated, each with this quantity of milk, from every goat at each examination. In plating, the milk was deposited on the centre of

a nutrose-agar plate and distributed all over the surface by means of a sterile L-shaped glass rod spreader. After suitable incubation, the colonies of *M. melitensis* that had developed on each of the three plates were enumerated and averaged, the contents per cubic centimetre calculated and the results obtained recorded in tabular form, and also plotted in a curve.

Table VII.—Numerical Strength of *M. melitensis* per cubic centimetre in Milk of Infected Goats.

Serial No. of goat	104.	105.	106.	107.	111.	112.	114.	115.	117.
1906—									
May 7...	4,000	nil	330	7,000	—	—	—	—	—
„ 10...	800	30,000	200	?	15,000	100	—	—	—
„ 15...	13,000	nil	nil	2,400	6,000	nil	—	—	—
„ 22...	30,000	nil	nil	6,000	30,000	nil	—	—	—
„ 26...	3,000	nil	nil	4,000	6,000	4,000	—	—	—
„ 29...	30	nil	nil	4,600	15,000	nil	—	—	—
„ 31...	nil	nil	nil	6,500	30,000	100	nil	6,000	8,000
June 2...	66	nil	nil	10,000	5,700	nil	30,000	15,000	8,000
„ 5...	7,500	nil	nil	6,000	12,000	30	4,300	30,000	30,000
„ 9...	nil	nil	nil	nil	20,000	nil	?	4,600	5,000
„ 12...	830	nil	nil	7,300	3,400	66	nil	30,000	30,000
„ 14...	nil	5,000	nil	10,000	8,000	100	1,760	5,500	30,000
„ 16...	66	nil	nil	500	6,000	30	14,000	100	nil
„ 19...	nil	nil	nil	nil	30,000	700	700	430	?
„ 21...	30	nil	nil	30	2,400	2,000	nil	23,000	1,200
„ 23...	130	nil	2,000	5,000	2,700	3,200	1,500	660	6,666
„ 26...	66	nil	2,000	15,000	13,000	30,000	20,000	1,000	13,000
„ 28...	200	nil	nil	30,000	12,000	2,600	15,000	2,500	20,000
„ 30...	1,500	30	400	30,000	23,000	1,000	18,000	4,700	23,000
July 3...	1,100	nil	330	3,000	6,170	66	16,000	8,000	30,000
„ 5...	400	nil	30	2,400	4,000	66	20,000	17,000	27,000
„ 19...	700	10,000	nil	23,000	—	—	—	—	—
„ 21...	—	—	—	—	730	nil	15,000	30,000	30,000
„ 24...	470	8,300	nil	2,300	—	—	—	—	—
„ 26...	—	—	—	—	1,000	nil	4,000	20,000	23,000
„ 27...	—	—	—	—	4,000	—	800	300	1,000
„ 28...	66	nil	nil	1,700	—	—	—	—	—
„ 31...	—	—	—	—	30	nil	30,000	1,700	16,000
Aug. 2...	16,000	1,200	nil	1,800	—	—	—	—	24,800
„ 4...	—	—	—	—	2,700	nil	3,000	730	nil
„ 7...	660	5,300	100	1,000	—	—	—	—	—
„ 14...	1,600	nil	540	20,000	nil	nil	nil	8,000	30,000
„ 18...	750	6,600	nil	720	10,000	nil	6,000	nil	nil

— = not examined.

In connection with this table a fallacy and an inaccuracy must be pointed out. In the first place, the fallacy consists in recording *nil* per cubic centimetre, when only three separate small amounts of milk —totalling in the aggregate but a little more than 0·1 c.c.—proved to be sterile or had failed to give rise to a single colony of *M. melitensis*.

Such a result, however, is amply sufficient to show that the *M. melitensis* content of the milk is extremely small, and, bearing this fallacy in mind, it is sufficiently accurate for the purposes of a comparative table to record such a result as *nil.* The inaccuracy relates to the other extreme. In enumerating colonies on a plate it is usual to count each individual colony, when the number does not exceed 1,000, by the help of radii drawn on the bottom of the glass dish with a grease pencil. Beyond this figure it is customary to observe the colonies by the aid of a low power objective, to enumerate those enclosed in several areas of the plate, and average the contents of such areas. For this purpose a 1-inch or a ⅔-inch objective, a suitable eye-piece and such particular length of tube is employed as will produce a field whose area bears a definite relationship to the total area of the plate, so that finally the approximate content of the entire plate is rapidly calculated from the content of an average field. The recorded figures between 100 and 1,000 may therefore be regarded as accurate; figures in excess of 1,000 calculated from the average contents of selected microscopical fields are probably highly inaccurate; but as in all these estimations care was taken to select the fields for counting from the least crowded portions of the plates the inaccuracy was always in the direction of underestimation. In some instances so obvious was the underestimation that 30,000, the highest figure recorded—as it was necessary to keep the curves that are presented herewith (see Fig. 2) within reasonable limits—is indicated in special type to show that, in the opinion of the observers, at least one other zero should be added, as the numbers were practically uncountable.

This difficulty in enumeration will be better appreciated by a glance at Fig. 1, which represents a plate inoculated with 0·035 c.c. of milk from Goat No. 111. With the exception of the few large colonies of saprophytic bacteria, all the colonies are due to the growth of *M. melitensis.* The milk from which this plate was prepared is returned as containing **30,000** *M. melitensis* per cubic centimetre.

On several occasions control plates were prepared with suitable dilutions of the milk samples, and it was frequently found that 3,000,000 per cubic centimetre would be much nearer the true content of the milk than the 30,000 recorded.

In this connection it may be remarked that the conditions under which work with goats' milk is carried out in Malta are totally different from those that hold in England, when the corresponding food, cows' milk, is being investigated. It must be obvious to those who are in the habit of working with cows' milk at home, that the enumeration of colonies of any specific organism, *e.g.*, streptococci, in plates prepared by smearing milk direct upon the surface of the medium, would be a hopeless task on account of the number of extraneous saprophytes present. With the Maltese goat, however,

having discarded the first few cubic centimetres of fore milk, the next quantum, the mid milk and the strippings, consist of sterile, or practically sterile, milk, in the case of the normally healthy milch goat, or a pure culture of *M. melitensis* in the case of the milch goat which is infected by *M. melitensis* and is voiding the germ in its milk. Some of the reasons for the clean character of the milk are fairly patent,

FIG. 1.—Nutrose agar plate prepared from 0·035 c.c. freshly drawn milk from Goat 111. All the minute colonies are composed of *M. melitensis*.

although the goat is an extremely dirty animal in its choice both of food and resting-place. Most important of all is the fact that the milk is examined within a very short time of its removal from the mammary gland of the goat—no long interval, occupied in transit by road and rail, is allowed for the multiplication of extraneous saprophytes. Again, in milking, the goatherd invariably crouches

directly behind the animal, and grasping the udder, drags it back between the hind legs, which the animal separates widely to allow of its passage. The receptacle for the milk, if small, is held in one hand some distance behind the animal and below the level of the teat, while the other hand, grasping udder and teat, directs an oblique stream of milk into it—in other words, the jet of milk and the receiving vessel hold the same relative positions as the inoculating platinum needle, and the test-tube respectively, when a tube culture is being prepared in the laboratory. If the receptacle for the milk is large, it is placed on the ground behind and well clear of the goat, and the goatherd, employing both hands, milks from both teats; consequently, any dirt and filth dropping from the udder and hindquarters falls more or less vertically to the ground, while the stream of milk traverses a stratum of clean air which does not usually add saprophytes to the milk during its passage; indeed, the freedom of the air and dust from saprophytic bacteria is a noteworthy feature of bacteriological research in Malta, and is due no doubt to the sterilising action of the direct rays of the sun—which are available for at least 12 hours per diem for the greater part of the year. Aerial contamination of cultivations in a laboratory kept moderately clean is rare, plate cultures can be made in the open air with a reasonable certainty that, where not intentionally infected, they will remain sterile, and plates may be opened and examined day after day without the preparations becoming contaminated.

For the moment the only explanation that can be offered of this day-to-day variation in the number of cocci present in the milk is that the micro-organism, lodged in a suitable soil and richly supplied with a medium of high nutritive value, multiplies rapidly in the interstices between and upon the surface of the gland epithelium cells. This multiplication proceeds up to a certain point, when, owing perhaps to the mechanical irritation set up by the mere presence of the coccus, a flushing process is carried out by the milk itself which removes the excess of cocci and leaves behind in the gland tissue only those cocci which are in intimate relationship with the gland cells. A certain interval necessary for the further multiplication of those cocci left behind elapses, then the process is again repeated, and so on.

Conversely, it is more than probable that the stimulus provided by the presence of the bodies of the cocci, or of their toxins, is an important factor in the large and long-continued milk yield of the infected milch goat.

In the accompanying Graph, the numbers of *M. melitensis* obtained at the periodic examinations of the milk from Goats 111, 114, 117 are plotted out in curves superposed on the curve representing the diurnal mean temperature of the air of Valletta. On the one hand, it will be seen that there is no direct association between discharge of cocci in the milk and rise or fall of air temperature; on the other, the

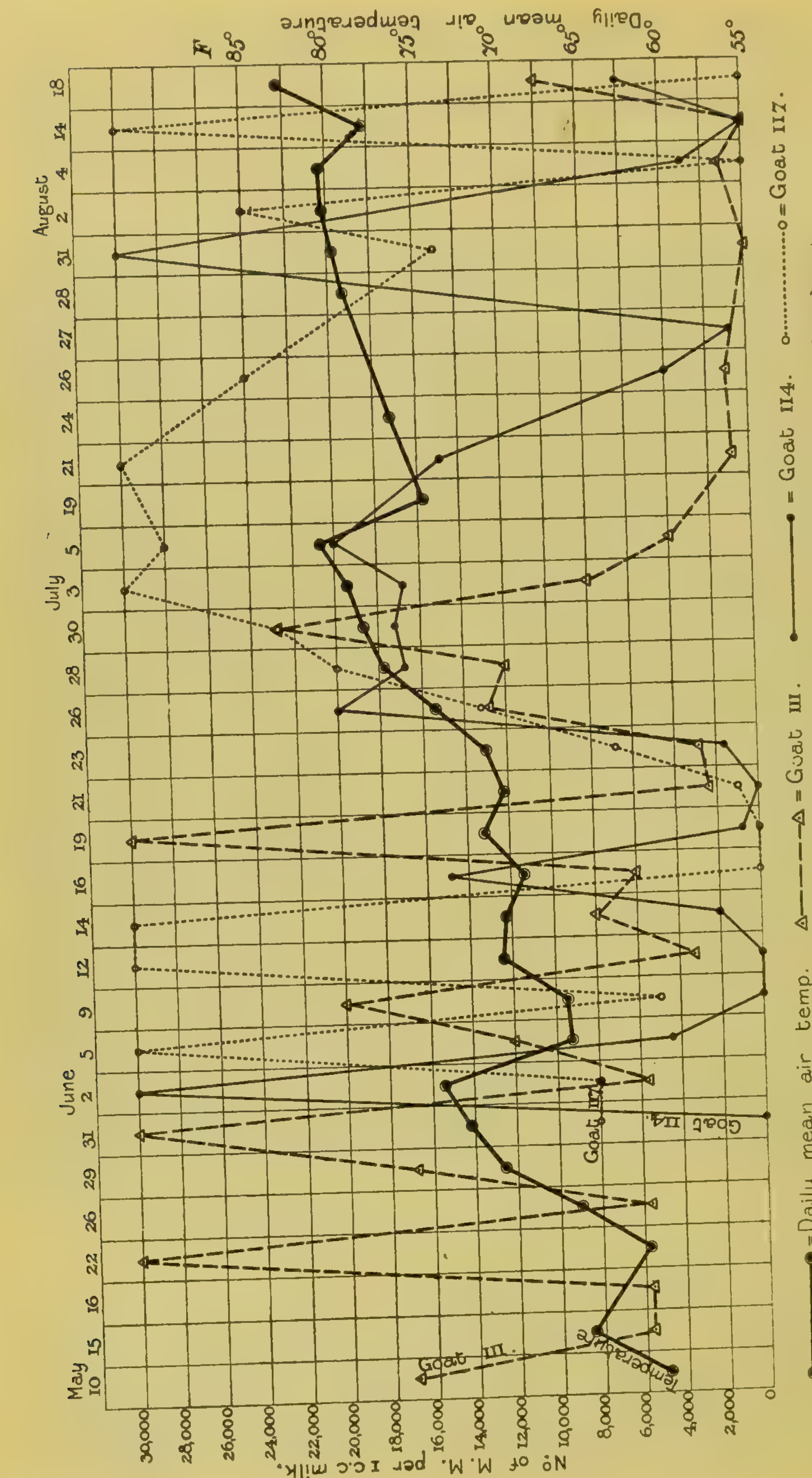


FIG. 2.—Curves showing the periodic variation in the *M. melitensis* content of milk of infected goats.

periodic discharge of large quantities of cocci and the variable interval during which but few cocci are present in the milk, are well brought out.

4. *The Presence of* M. melitensis *in Milk Products.*

The fact elicited as the result of the examination of a very large number of animals, that at least 10 per cent. of the milch goats in the Island of Malta secrete milk which contains the specific germ of Malta Fever in divers quantities, rendered it extremely likely that the micrococcus might pass unscathed through the various manipulations to which milk is subjected in the preparation of articles of food such as cheese, etc., and some observations were accordingly made in this connection.

Cheese.—The native cheese in common use is a whole milk cheese, and is prepared in a very simple and primitive manner. Acid or rennet is added to the sheep's or goat's milk, and the resulting curd is "set" in open basketwork moulds which allow the whey to drain off, placed aside overnight, and is ready for consumption the following day. Such a cheese is, of course, eaten fresh, as its method of preparation hardly fits it for prolonged storage.

At first sight it would appear probable that the high degree of acidity present in the cheese (a fair average would be + 80 or + 90 as compared with an optimum of + 8 or + 10 aimed at in preparing nutrient media for the cultivation of *M. melitensis*) would ensure the destruction of the micrococcus. A reference, however, to the work of Shaw* shows that the micrococcus can retain its vitality in urine, having a reaction of + 40, + 50, or + 60; and, again, it was noted in carrying out certain experiments as to the presence of agglutinins and of the specific coccus in whey, prepared from infected milk, that the coccus retains its vitality in this highly acid whey, while the diminution in number in this whey as compared with the original milk would suggest that numerous cocci remain entangled in the curd, quite as much as that numerous cocci are killed off by the acid present.

The first sample of cheese to be examined was obtained 24 hours after setting, direct from its manufacturer, a peasant farmer near Zebbug, who kept a herd of 13 milch goats and one milch sheep. (Seven of his goats, the sheep and a sow were subsequently found to be infected, and the goats and sheep were secreting milk containing *M. melitensis*. These animals, purchased by the Commission and lodged in the Lazzaretto, afforded material for many of the observations recorded in the previous pages.)

Plate cultivations in series on the surface of nutrose-agar were established in the usual way from pieces cut from the centre of the

* These Reports, III, p. 43 *et seq.*

cheese with a sterile knife, after well searing the surface with a red-hot iron: and also from 0·1 c.c. of an emulsion prepared by breaking up approximately 0·1 gramme of cheese in 10 c.c. of sterile broth. Three plates only were prepared in each series, and after incubation it was found that the dilution was insufficient, as all were crowded with saprophytic bacteria which rendered the "fishing" of the colonies of *M. melitensis*, which were recognised with the hand lens, a matter of impossibility. Scrapings from the plate, which included colonies of the coccus as well as neighbouring saprophytes, when emulsified in distilled water and added to a 1 in 250 dilution of specific serum, showed microscopically typical clumps of *M. melitensis*. Ordinary sub-cultures failed to give a growth of the micrococcus, and as it was considered waste of time to continue work on this cheese, the plates were abandoned and further experiments made with cheeses prepared in the Lazzaretto from the milk of the identical infected sheep and goats—now the property of the Commission—from which this first specimen had been manufactured.

Numerous cheeses were made and each examined repeatedly during several days, and it was found that by careful attention to the question of dilution in preparing the series of plates, it was a fairly easy matter to isolate the coccus from the cheese up to the end of 48 hours. After this time the multiplication of lactic acid and other bacteria outstripped that of *M. melitensis*, and it was no longer possible to recover the organism.

Ice Cream.—With the advent of hot weather, soon followed by the discovery that the ordinary private soldier does purchase ice-creams in the local cafés and consume them, attention was directed to this milk product. Enquiry elicited the fact that, as in England, two varieties of ice-cream are in vogue, the one prepared by freezing a flavoured custard of milk and eggs previously heated to about 80° or 90° C. and cooled, the other by flavouring milk to which cream may or may not be added, with various essences or syrups and freezing—the former being the more expensive. As by this time the infectivity of goats' milk was becoming a matter of common knowledge among the Restauranteurs of Malta, one individual volunteered the information that he always boiled his goats' milk before using it in the manufacture of ice-cream. On the other hand, it has been stated by a private in the Royal Army Medical Corps that a café keeper who had run out of his stock of ices would milk the goat tied up to his door post, and some 20 minutes later produce the ice-cream to his customer.

Experimental ice-creams of both types were, therefore, prepared in the laboratory from milk derived from the infected herd at the Lazzaretto, and then examined for the presence of the *M. melitensis*. In the case of those made from a custard of milk, eggs, and sugar, and heated to about 80° C. to ensure the thorough incorporation of

the ingredients, it was found impossible to recover living *M. melitensis*, although it was known they were present in abundance in the infected milk—from the result of plate cultivations established prior to heating. This was only to be expected, as the thermal death point of the organism in watery suspension has been determined as 57·5° C.

In the case, however, of the second type of cream where no heating is resorted to, it was found to be as easy to recover *M. melitensis* from such as had been prepared from infected milk as it was from the milk itself.

With these data to work upon, a series of examinations of samples of ices from various cafés was instituted. The ice-cream, on arrival in the laboratory, was placed in the incubator at 37° C. for an hour or two to thaw. The ortol and peroxide of hydrogen test* was next applied to determine whether or no the milk had been boiled or had been heated above 70° C., although often ocular observation was sufficient in the case of such as had been prepared from custard. In the event of the sample of cream having been made from custard, the specimen was, of course, discarded, but if it responded to the test and gave the characteristic reaction associated with unheated milk, then plate cultivations in series were established from the cream and set aside in the incubator. Some of the fluid portion of the ice-cream was diluted to 1 in 10, with sterile water added to an equal quantity of emulsion of *M. melitensis*, taken up in sedimentation tubes and set aside for observation as to the presence or absence of agglutinins.

If, on the following morning, the sedimentation reaction was absent, the plates made from that particular ice-cream were discarded, as previous experiments in this connection (p. 18) had shown that *M. melitensis* was never recovered from milk in the absence of a good agglutination reaction in dilution of 1 in 20.

In all, 11 samples of retail ice-creams were examined before illness interfered with the investigation. Three had been prepared from heated custard, and were consequently discarded; four others, prepared from unheated milk, were plated out, but as on the following morning the sedimentation reaction was absent, these plates were not proceeded with. The four remaining samples—made from unheated milk—yielded a complete sedimentation reaction, and the plates

* This is a test introduced by Saul some few years ago, and depends upon the fact that the addition of ortho-methyl-aminophenol sulphate (or of ortol, an impure preparation of the same salt, used chiefly in photographic work) to raw milk in the presence of nascent oxygen, gives rise to a brick-red coloration within 30 seconds of mixing. With milk which has been heated at or above 70° C., no change is observed.

In practice the test is carried out by adding 1 c.c. of a freshly prepared aqueous solution of ortol (1 per cent.) to 10 c.c. of milk in a test-tube and then adding one or two drops of hydrogen peroxide (3 vols.).

prepared from them were carefully worked out, but with negative results; *M. melitensis* could not be detected.

Further investigations in this direction are now in course of prosecution.

Butter.—As practically all the butter consumed in the island is imported tinned butter and margarine, no examinations of samples of this food were made.

5. *Susceptibility of the Goat to, and Paths of Infection by* M. melitensis.

As the results of the examination during the years 1905 and 1906 of a very large number of animals scattered throughout the island had revealed the fact that, roughly, some 10 per cent. of the milch goats were secreting milk containing the coccus, while some 30 per cent. more by the existence of fair quantities of specific agglutinins in the blood serum and milk afforded the strongest presumptive evidence of previous infection, it is obvious that the goat is distinctly susceptible to the pathogenetic influence of *M. melitensis.* The experimental work carried out during the same years also showed clearly that the goat could be infected, with a fair amount of ease, by the ordinary laboratory methods of inoculation—that is by the subcutaneous and intravenous injection of living cultivations of *M. melitensis*—and also by feeding, either with artificially or naturally infected material.

These observations rendered any extended series of experiments in similar directions needless; on the other hand, no experimental results were available with regard to infection by contact, such as had already been shown took place in the case of monkeys in close proximity to each other.*

Contact Infection.—Two yearling female goats—Nos. 22/5 and 23/5—which had not yet been impregnated, and consequently were not "in milk," and from whose blood specific agglutinins were absent, were, therefore, turned loose into a large stable in company with 16 infected milch goats and one infected milch sheep, from all of whose milk *M. melitensis* was obtainable in varying numbers. None of the animals were tethered; consequently the contact was as intimate as possible, while the fact that neither of the two experimental animals were included in the daily milkings eliminated the likelihood of transmission of infection viâ the goatherds' hands. Eight days after the commencement of the experiment the blood serum of Goat No. 23/5 yielded a partial agglutination reaction in a dilution of 1 in 10; on the following day the serum from Goat No. 22/5 gave a similar result, and on the 16th day both goats gave a complete positive agglutination reaction in dilutions 1 in 10 and

* *Vide* these Reports, I, p. 67.

1 in 20. Subsequent examination of the blood serum from each goat showed those fluctuations of the agglutination curve that are usually associated with *M. melitensis* infections, and the serum value six weeks after the commencement of the contact reached 1 in 100. At the end of four and a-half months both goats were killed and examined *post-mortem.* The organs that were examined after death were spleen, inguinal glands, mesenteric glands, and kidneys, and from none of these was *M. melitensis* recovered. This failure to detect the specific micro-organism *post-mortem* in the case of infected goats has by no means the same significance that it would have in other experimental animals, a point which will be referred to in a succeeding section.

In this experiment infection may have taken place through actual contact, the ingestion of fodder saturated with infective milk or urine, convection by ordinary flies, transmission of the coccus by means of biting flies, etc., the conveyance of infective material on the goatherds' hands alone being eliminated.

Of the various methods above mentioned, it may be pointed out that some would be excluded under ordinary circumstances. For instance, in the native goat-house the goats are usually tied up on either side of a raised trough containing food, from which few or many feed in common, by a length of rope sufficient to permit of the animal lying down. Each animal retains the same position from day to day; consequently contact in the stable is limited to the neighbouring goats on either side, and when the troughs are arranged in rows to the animal immediately behind also, and it is a noteworthy fact that in many cases it is either the next-door neighbour or the goat immediately behind the infected goat that next becomes infected, and not the goat on the opposite side of the trough. When taken out of the goat-house to start on the daily milk round, contact is more promiscuous, though here, again, stable companions are said to keep together.

Subcutaneous Infection.—It next appeared desirable to determine whether comparatively small doses of living cocci from artificial cultivations could be depended upon to produce infection. For this purpose four normal, healthy, young kids were selected, and when repeated observations had shown that specific agglutinins were absent from the blood, they were injected subcutaneously, each with a different sized dose of infective material.

The strain of *M. melitensis* employed for the experiment was a first sub-culture (from a single colony) of the coccus isolated from the milk of Goat No. 111—one of the infected milch goats under observation in the Lazzaretto.

The actual culture used was a 48-hours agar-tube growth. One loopful*

* An ordinary agar slope cultivation would be equivalent, approximately, to 50 such loopfuls.

Table VIII.—Inoculation Experiments with the Goat.

No. of goat.	Sex.	No. of cocci injected.	Bulk of infective emulsion.	Method of inoculation.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.					
									M. melitensis recovered from—				
					Day of appearance.	Amount of dilution.		Value of serum.	10 c. mm. of blood.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
10	♂	10,000,000	c.c. 1·0	Subcutaneously at root of left ear.	7	1 : 20	47	1 : 200	–	+	+	–	+
9	♂	1,000,000	0·1		7	1 : 20	47	1 : 100	–	+	–	+	+
5	♀	100,000	0·01		17	1 : 20	46	1 : 20	–	–	–	–	+
4	♀	10,000	0·001		17	1 : 10	46	1 : 20	–	–	–	–	+

of this growth was emulsified in 10 c.c. of sterile saline solution, and the four goats were inoculated subcutaneously at the root of the left ear with 1, 0·1, 0·01, and 0·001 c.c. respectively of the emulsion. Portions of the remainder of the emulsion, after suitable dilution, were plated out and incubated. Enumeration of the resulting colonies showed that the emulsion contained 10,000,000 cocci per cubic centimetre.

Consequent upon these injections all four goats became infected: the blood serum from the first and second yielding a positive agglutination reaction with 1 in 10 and 1 in 20 dilutions on the seventh day. Serum from the third did not give a positive reaction until the seventeenth day in these dilutions, whilst the fourth, although giving a positive reaction in 1 in 10 dilution, gave an incomplete reaction only with 1 in 20 on the seventeenth day, and not until the thirtieth day did the serum react well with 1 in 20 dilution.

From the clinical point of view there is little to record in connection with these inoculated goats. At no time during the course of the experiment did either of the goats appear to be ill—their coats were in good condition, no glandular enlargement was to be observed on palpation, and the animals fed well, as usual. The temperature was somewhat irregular, but in this respect none differed markedly from the healthy animals that served as controls, as will be seen from the temperature charts (*vide* p. 32) of the four experimental animals and the one of the normal animals in an adjoining stable that showed the least extensive excursions from the normal line (which for the goat averages, according to Damant,* 103·5—104° F.), and so served as a control.

All the animals were killed at the end of six weeks, and at the *post-mortem* inspection ample evidence of *M. melitensis* infection was available in the recovery of the organism from the spleen in all four goats, and in three of them from other organs as well. Details of this experiment are shown in tabular form (see Table VIII).

A point of some interest may be noted in this experiment with regard to the relationship of the size of the dose of infective material to the date of onset of signs of infection. Thus the two first goats, which received 10 and 1 million cocci respectively, gave evidence of reaction to the infection, by the appearance of specific agglutinins in the blood, within a week of inoculation and a full 10 days earlier than the other two goats which had each received less than a million cocci.

Cutaneous Infection.—The suspicion that had been aroused with reference to the probability of infection being carried from goat to goat by way of the goatherd's hands when soiled with infective milk was strengthened by the knowledge that such a comparatively small amount of infective material injected subcutaneously was sufficient to produce infection.

The technique adopted by the Maltese milker closely resembles

* 'Journ. Physiol.,' Cambridge, 35, 1906 (Proceedings, v).

Chart No. 1.

KID 15 ♀ (control)

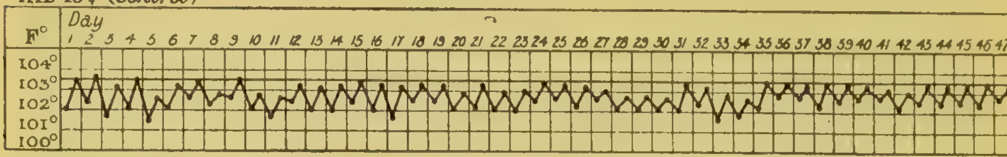


Chart No. 2.

KID 10.

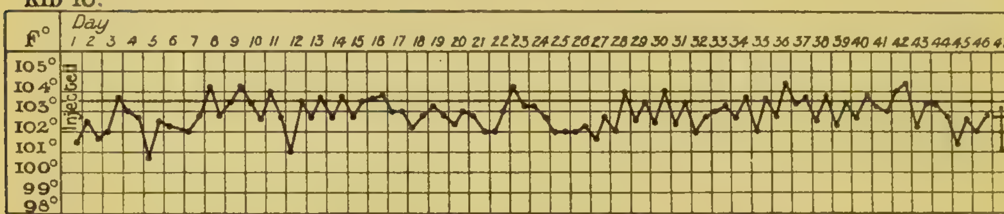


Chart No. 3.

KID 9.

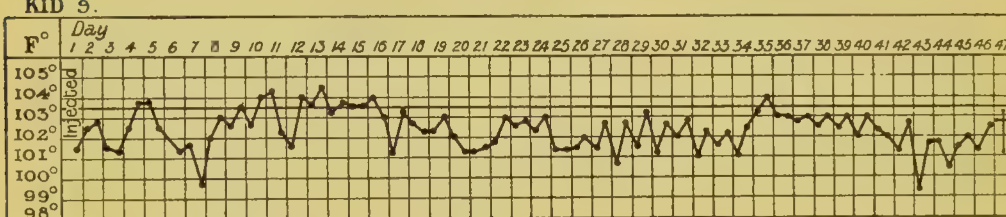


Chart No. 4.

KID 5.

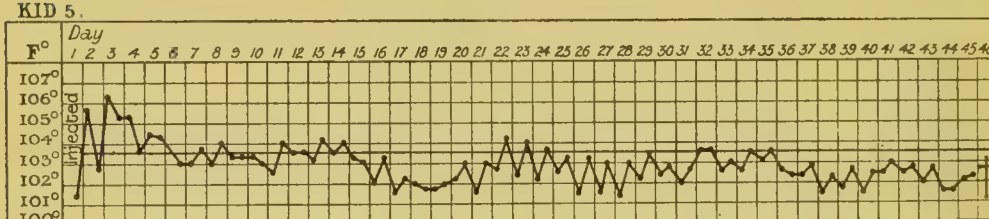
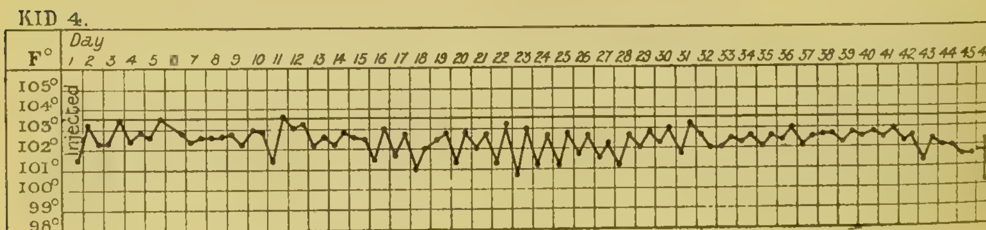


Chart No. 5.

KID 4.



Subcutaneous Infection of the Goat.

that of his English confrère, and consists in lubricating his own hands and the outside of the udder with some of the foremilk. When a number of goats have to be milked in rapid succession, the lubricant obtained from the first goat will serve for perhaps some half-dozen goats; with the seventh goat a fresh supply of milk is taken for the same purpose, and so on. Now, given that Goat No. 1 or Goat No. 7 is passing *M. melitensis* in its milk, it is obvious that, at any rate, Goat No. 2 or No. 8, as the case may be, stands a very good chance of becoming infected by a process of subcutaneous inoculation; consequently steps were taken to investigate the possibility of this occurrence.

In carrying out this experiment, the procedure of the goatherd was imitated as closely as possible, and Goat No. 25/6, a healthy female, nearly full grown, was selected for the purpose of the experiment, cast on an operating table and securely held by assistants. A fairly large area of skin over the left mammary gland was shaved somewhat roughly, in such a manner as to remove in many places the superficial layer of epithelium as well as the hair, but care was taken to avoid drawing blood. Thus the shaved area replaced the scratches, abrasions, and small ulcers that are so frequently seen in the udder and teats of the milch goat.

Next, the hands of the operator being protected by a pair of sterilised indiarubber gloves, four drops of freshly-drawn milk from Goat No. 117 (amounting in total bulk to 0·2 c.c.) were delivered into the palm of the right hand from a sterile capillary pipette, and then thoroughly rubbed into the shaved area with movements similar to those practised by the goatherd as a preliminary to milking. The quantity of milk used was so small that the skin surface rapidly dried, and the goat was then isolated in a stall apart from the other animals. Immediately after the experiment was concluded, a sample of the milk that had been used was carefully plated out (after suitable dilution) and found to contain 24,800 *M. melitensis* per cubic centimetre; the approximate number of cocci, therefore, that came into contact with the prepared area of skin amounted to 5,600.

Samples of blood were taken from a vein in the ear of this animal and examined from day to day for the presence of specific agglutinins, which first made their appearance on the fifteenth day (dilutions 1 in 10 and 1 in 20).

Three weeks after inoculation the goat was killed and a careful *post-mortem* examination carried out, with the result that the specific organism was recovered from the spleen and inguinal glands.

At the same time Goat No. 23/6, a four-month-old female kid which appeared quite healthy, was selected as a control. The skin over the mammary gland was carefully examined with a hand lens, and an area quite free from scratches, cracks, or fissures was isolated by painting flexile collodion on the surrounding skin. Eight drops of milk from

Table IX.—Cutaneous Inoculation of the Goat with *M. melitensis*.

No. of goat.	Sex.	No. of cocci inoculated.	Bulk of infective milk.	Method of inoculation.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.					
								Value of serum.	*M. melitensis* recovered from—				
					Day of appearance.	Amount of dilution.			10 c. mm. of blood.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
25	♀	5,600	c.c. 0·2	Infective milk rubbed into prepared area of skin.	15	1 : 20	20	1 : 100	–	+	+	–	+
23	♀	11,200	0·4		—	—	18	—	–	–	–	–	–
Cf. also Monkey No. 188	♂	13,250	0·2		13	1 : 50	17	1 : 200	+	+	+	+	+

Goat No. 117 was then deposited on the centre of the prepared area and rubbed into the skin with the top of the forefinger—still protected by the rubber gloves. When dry, the kid was released, isolated in a separate stall, and subsequently specimens of blood were examined from time to time with negative results until the eighteenth day after inoculation, when the kid, which had been refusing its food for nearly a week, died.

According to the animal attendants, death was due to the fact that an inferior batch of fodder, on which it had been feeding, was an unsuitable food for so young a goat. Be this as it may, at the *post-mortem* examination, beyond absence of fat and emaciation, no obvious cause for death could be detected. *M. melitensis* could not be found in any of the organs nor in the subcutaneous tissue or skin at the seat of inoculation, and specific agglutinins were absent from the blood serum.

The successful result attending the cutaneous method of inoculation in the case of Goat No. 25/6—a method closely resembling that employed in Jennerian vaccination—renders it extremely probable that convection by the flies which positively swarm in the goat pens, may play a part in the transmission of the infection from goat to goat. First settling on drops of infective milk or urine, soiling body and legs, as well as proboscis, and then flying to a scratch or friction ulcer on a previously healthy goat, whether on udder or other part of the body, it would be a very easy matter for the fly to deposit a sufficient number of *M. melitensis* on the raw surface to ensure infection.

The result of the foregoing experiments, together with some observations made in connection with inoculation through the apparently uninjured mucous membrane of the external genitals of the monkey (*vide* p. 113), render the probability of infection of the goat during impregnation extremely likely—a probability which, so far as the male is concerned, is rendered still more likely owing to the fact that the female urethra opens into the floor of the vagina a couple of centimetres or more within the orifice of the canal, so that when the animal is passing *M. melitensis* in the urinary excretion the coccus must be present near the mouth of the vagina in considerable numbers. Unfortunately it was not feasible to test this method of infection experimentally, for, although numerous healthy and infected males were forthcoming, the late season rendered efforts to secure healthy and infected females in suitable condition for such experiment fruitless.

Transmission of the coccus by means of blood-sucking flies, other than by mechanical conveyance upon body or limbs, for example, by *Stomoxys calcitrans*—which abounds in the goat stalls—appeared from the experiments carried out during the summer to be extremely improbable. The negative results obtained in this connection are detailed later (see p. 99).

6. *The Localisation of* M. melitensis *in the Infected Goat.*

Inoculation of the goat with *M. melitensis* produces what must be regarded as an acute, or more commonly a sub-acute, septicæmia—the specific organism living and multiplying in the circulating blood for a variable, often a considerable period—which but rarely proceeds to a fatal termination.

Except on rare occasions when for the few days immediately following inoculation the temperature is raised, the constitutional disturbance accompanying infection is but little marked, and soon ceases to be demonstrable; later on the presence of the specific organism can be detected in excretions and secretions, viz., the urine or milk, or both; but these phenomena are by no means constant. Observations were therefore undertaken as opportunity offered with a view to tracing the route followed by *M. melitensis* in the course of the disease as observed in goats, by studying the *post-mortem* localisation in cases of different durations in the light of the information derived from similar observations on the course of the disease in the monkey.

The results obtained, however, are extremely conflicting (*vide* Table X), and the general statement to be formulated immediately, although probably true in the great majority of goat infections, can only be accepted at the present stage of the investigations as a pious opinion or a working hypothesis.

During the early stages of the infection the blood stream and the spleen are the chief seats of *M. melitensis* activity: later the coccus becomes localised to the speen, lymphatic and other glandular structures and kidneys, probably by the operation of a process akin to filtration, but during its existence in the spleen the possibility of its re-appearance in the blood is ever present. Later still those foci present in the kidneys are destroyed, next those in the spleen, then those in the general lymphatic glandular system, so that in infections of long duration the coccus may be absent from all and every organ with the exception of the mammary gland, where it may persist for very extended periods.

In addition to tabulating the observations upon which the opinions enunciated above are based, it will be well to discuss in order the chief organs and tissues from which *M. melitensis* has been isolated.

1. *The Blood.*—Zammit, working with naturally infected goats, noted that "in certain phases of the disease the specific microbe circulated freely in the blood, but that this condition did not last long."* Again, Eyre, whilst using living cultures in the attempt to immunise the goat and the horse, found that living cocci could be isolated from the peripheral blood for about four weeks after an injection.†

* *Vide* these Reports, IV, p. 97.

† Reports, V, pp. 45 and 49.

During the period of incubation, that is to say, between the moment of actual infection and the rapid multiplication of the coccus in the circulating blood, usually some 7 to 21 days, attempts to isolate the coccus from peripheral blood are invariably unsuccessful.

Referring once more to the immunising experiments, it was observed that during the first fortnight after the intravenous injection of living cultures of *M. melitensis* it was a comparatively easy matter to isolate the coccus from peripheral blood, although in gradually decreasing numbers, by simple cultivation methods; by the third week the numbers present were small, and after the fourth week it was not possible to detect the presence of the micrococcus either by cultivation or inoculation experiments.

Then, too, in none of the animals tabulated below was the specific coccus isolated from the heart blood, although one was examined *post mortem* three weeks after infection.

Zammit, however, remarked that some of the goats from whose blood he isolated the micrococcus were undoubtedly cases of long standing, a statement based on a consideration of the physical condition of the goats to which he refers; and the fact that two of them were in poor condition and were passing *M. melitensis* in the milk, lends support to the inference. While it is true that these cases might really have been recent infections, the physical condition and presence of the coccus in the milk being due to the exceptional severity of the infection, this is hardly likely; and the more probable explanation is that in cases of long duration, temporary re-infection of the blood stream sometimes occurs from foci in the spleen—a condition analagous to that observed in man during the course of protracted cases of Malta Fever.

In the majority of cases, therefore, the ready isolation of the coccus from the peripheral blood by cultivation methods would afford strong support to a diagnosis of recent infection.

Spleen.—As will be seen from the synopsis of *post-mortem* findings in Table X, it is quite the rule to isolate the micrococcus from the spleen in cases of short duration and up to about 12 months after infection, at any rate where the infection has been experimentally produced. In animals where the infection has existed for a considerable period (many of the *post-mortems* being carried out on animals which were naturally infected when purchased and had been under observation for periods extending over 12 to 20 months) it is the exception rather than the rule.

Lymphatic Glandular System.—There is as a rule in cases of long duration, as well as the more recent ones, a general enlargement of the lymphatic glands, from all of which the *M. melitensis* can be isolated. In recent infections those glands draining the location of the primary infection contain numerically more of the cocci than those which have

Table X.—Results of *Post-mortem* Examinations of Goats.

No.	Sex.	Remarks.	Duration of infection or period of observation.	Presence of *M. melitensis* noted during life.		Serum value at death.	*Post-mortem* findings. *M. melitensis* present in—					
				Urine.	Milk.		Heart blood.	Spleen.	Kidney.	Glands. Inguinal.	Glands. Mesenteric.	Udder.
			weeks.									
25	♀	Cutaneous inoculation ...	3	—		1 : 100	—	+	—	+	—	0
10	♂	Subcutaneous inoculation	6	—	—	1 : 200	—	+	—	+	—	0
9	♂	" "	6	—	—	1 : 100	—	+	—	+	+	0
5	♀	" "	6			1 : 20	—	+	—	—	—	0
4	♀	" "	6	—	—	1 : 20	—	+	—	—	—	0
Rosso	♀	" "	21	—	—	1 : 1500	—	+	—	—	+	0
XXV	♀	Fed with infected milk...	26	—	—	1 : 100	—	+	—	+	—	0
IV	♀	Fed with emulsion of culture	37	—	At 7 wks.	1 : 20	—	—	—	—	—	—
Bianca	♀	Subcutaneous inoculation	39	—	—	1 : 20	—	+	—	—	—	0
VIII	♀	Fed with infected milk...	41	—	—	1 : 10	—	—	—	—	—	0
XII	♀	Fed with emulsion of culture	42	—	—	?	—	+	—	—	—	0
XIII	♀	Fed with urine infected dust	45	—	At 13 wks.	1 : 10	—	—	—	—	—	0
X	♀	Fed with infected milk...	49	—	At 20 wks.	1 : 20	—	—	—	—	—	+
XI	♀	?	49	—	—	1 : 50	—	—	—	—	—	—

VII	♀	Fed with emulsion of culture	53	—	At 43 wks. to day of death	1 : 160	—	—	—	—	—	0
102	♀	Naturally infected.........	19	—	—	1 : 20	—	—	—	—	+	0
103	♀	,, ,, ...	19	—	—	1 : 20	—	—	—	—	—	0
118	♀	,, ,, ...	19	—	—	1 : 10	—	—	—	+	—	0
XIX	♀	,, ,, ...	43	—	At 20 wks.	1 : 160	—	—	—	—	+	+
III	♀	,, ,, ...	56	+	+	?	—	—	—	—	—	0
I	♀	,, ,, ...	60	+	+	?	—	+	+	—	—	0
II	♀	,, ,, ...	60	+	+	?	—	—	—	—	—	0
V	♀	,, ,, ...	60	+	+	?	—	—	+	—	—	0
VI	♀	,, ,, ...	60	+	+	?	—	—	—	+	—	0
XV	♀	,, ,, ...	60	—	—	?	—	—	+	—	—	0
XVI	♀	,, ,, ...	60	—	—	?	—	—	—	+	+	0
XVII	♀	,, ,, ...	60	—	—	?	—	—	—	+	—	0
XVIII	♀	,, ,, ...	60	—	—	?	—	—	—	—	—	0

— = *M. melitensis* not recovered. + = *M. melitensis* recovered. 0 = not examined.

merely derived their bacterial content from the circulating blood, and in the very early stages (*vide* Goat No. 25) the former glands may alone contain the coccus in demonstrable quantities.

Towards the termination of the infection the lymphatic glands—particularly the inguinal—appear to be the last resting place of the coccus before its final destruction, and in a previous report* this fact has been commented upon by various workers who have expressed the opinion that had the examination of the superficial lymphatic glands in the case of many infections of long standing been neglected, *positive* evidence of infection by the isolation and identification of the *M. melitensis* would have been entirely missed. On the other hand, the evidence available by no means justifies the opinion, also there expressed, that the lymphatic glands were the site of especial reproductive activity on the part of *M. melitensis.* That the glandular infection is not limited to those glands draining the area first infected is well shown in the *post-mortem* results of inoculated monkeys (*vide* pp. 34, 51, and 114) which were examined in the early stages of the disease. In the cases, for instance, of food infection, inguinal and axillary glands as frequently yielded a copious growth of *M. melitensis* as the mesenteric (or bronchial and cervical, although these last are not included in the tables); and in the case of a cutaneous infection (Monkey No. 188) as well as in those of mucous membrane infection (Monkeys No. 200 and 203) when the mesenteric glands gave a growth equal to that from any of the subcutaneous glands.

Kidney.—Although the presence of *M. melitensis* in the tissues of the kidney practically synchronises with the appearance of numerous cocci in the blood stream, the extrusion of the micro-organism in the urine is in the majority of the experimental animals a somewhat late phenomenon. In man, on the other hand, the coccus may be demonstrable in the urine quite early in the acute stages of an attack of Malta Fever. In the rabbit and guinea pig its appearance—although usually late—is fairly constant; in the goat, however, the elimination of the coccus is by no means constant even in cases of very long standing, and it is of interest to record the fact that frequently repeated examinations were made of the urine from all of the infected milch goats, some 20 in number, under observation at the Lazzaretto over a period of about a couple of months without the presence of the coccus ever being detected—although 18 of the animals were eliminating large numbers of the coccus almost daily in the milk. Again, the discharge of the coccus in the urine in cases where it has been observed appears to cease long before its disappearance from the milk.

Mammary Gland.—In the few *post-mortem* observations that were made as to the presence of *M. melitensis* in this situation, it may be

* *Vide* these Reports, IV, p. 69.

noted that the organism was detected distributed throughout the substance of the gland in the case of a goat that had previously yielded the coccus in its milk but had been "dry" for some weeks before it was killed. In three other cases small pieces of the base of the udder, containing the deepest portions of the glandular tissue, were removed. In one (where the coccus had appeared in the milk after the lapse of seven weeks from the date of infection) killed eight months after infection, the coccus could not be recovered from the mammary gland or any other of the organs examined. In another which had never shown *M. melitensis* in the milk during life, and which was killed ten months after experimental infection, the micrococcus was absent from all organs and tissues. In the third, killed 12 months after experimental infection, the coccus was isolated from the mammary gland alone of all the tissues examined.

Where the milk has been systematically examined in animals that have been experimentally infected, the appearance of the coccus in the milk has invariably been a late phenomenon. Goat No. 4, for example, commenced to eliminate the coccus seven weeks after infection, Goat No. 8 three months. Goat No. 7, on the other hand, was infected in September, 1904, and, although repeatedly examined, showed no signs of the coccus in the milk up to January, 1906, when, being "dry," she was impregnated. In July, 1906, she dropped two kids, and three days later the coccus appeared in the milk and was consistently present up to 24th September, when she was slaughtered, and it is interesting to note that in this case the coccus could not be recovered *post mortem* from either spleen, kidneys, or lymphatic glands.

7. *The Transmission of* M. melitensis *Anti-bodies to the Descendants of Infected Goats.*

A further interesting point, and one which has a considerable bearing upon practical preventive measures against the spread of *M. melitensis* infection in the goat, is the fact that while an appreciable amount of specific agglutinin is usually transferred from the infected milch goat to its offspring, the *M. melitensis* itself, minute though it is, does not appear to cross the placenta.* These observations were repeated on several occasions as opportunity offered, and the details concerning four kids born of experimentally-infected mothers (all

* One observation upon the human subject where transference of the micrococcus from the maternal to the fœtal circulation appears to have taken place *in utero* may here be referred to. A pregnant woman (under the care of Captain Williams, R.A.M.C., in the Married Families Hospital, Valletta) gave birth to a male infant during one of the pyrexial periods of an acute attack of Mediterranean Fever. The infant proved to be infected also, the agglutination value of its serum was 1 in 1000—as compared with its mother's 1 in 500—and its temperature curve from birth followed precisely that of the mother, although about half a degree lower, during the subsequent fluctuations.

of which were passing *M. melitensis* in either milk or urine, or both, up to the time of impregnation, and even after), may be tabulated as follows :—

Milch goat.	Kids born.	Serum value in kid.	Kid killed.	*Post-mortem* results *qua M. melitensis*.
1	25.10.05	1 : 50	13.11.05	Nil.
2	2.3.06	1 : 800	4.3.06	Nil.
3	14.7.06	*a* 1 : 50	31.7.06	Nil.
		b 1 : 20	31.7.06	Nil.

Even the small amount of agglutinin present in the serum of the kids of infected goats appeared to be associated with a very definite immunity, for the two kids of Goat No. 3 were fed for 17 days on their mother's milk, and for the last 10 days of this period the milk was teeming with *M. melitensis*, yet, at the *post-mortem* inspection, no trace of *M. melitensis* infection could be detected.

On the other hand, two kids which had been dropped, and subsequently reared by a similarly infected mother, were injected subcutaneously, when they were seven weeks old, with emulsion of cultivation of *M. melitensis*, and were quite unable to resist infection, showing that the resistance offered to invasion by *M. melitensis* can readily be overcome.

8. *The Treatment of Infected Milch Goats with the* M. melitensis *Vaccine.*

The lengthy periods over which apparently healthy milch goats continue to secrete milk of a highly infective character rendered it desirable to inquire into the utility of therapeutic measures in determining the duration of active infection. To this end observations were commenced with regard to the effect of treatment by *M. melitensis* vaccine, as it appeared useless to try any of those drugs that had already proved useless in the treatment of *M. melitensis* infection in the human subject.

Consequently, early in August a batch of vaccine was prepared from a highly virulent strain of *M. melitensis* in the manner described in Section VII, p. 116, and standardised to 1000 million micrococci per cubic centimetre. Seven of the herd of infected milch goats and sheep stabled in the Lazzaretto were selected for the purpose of the experiment—four for treatment, Nos. 104, 111, 114, and 117 ; and three—105, 107 (sheep), 115—to serve as controls ; the milk from all of these animals usually contained *M. melitensis*—often in enormous numbers—as will be seen by reference to Table VII, p. 20. Unfortunately, Goats Nos. 105 and 111 "dried up" shortly after the experiment was started.

The bi- or tri-weekly enumeration of the cocci present in the milk of these seven animals was continued, and observations on the agglutination reaction in serum and milk were also carried out.

Table XI.—*M. melitensis* in Milk of Vaccinated Goats and Controls.

Animal and No.	Goat 104.	Goat 114.	Goat 117.	Controls.	
				Goat 115.	Sheep 107.
Aug. 2 ...	16,000	30,000	24,800	—	1,810
,, 4 ...	—	30,000	—	730	—
,, 7 ...	660	—	—	—	1,000
,, 8 ...	Injected with vaccine (500,000,000 cocci)				
,, 9 ...	1,250	8,300	1,200	3,800	300
,, 11 ...	50	3,000	16,000	3,500	2.500
,, 14 ...	1,600	nil	30,000	8,000	20,000
,, 17 ...	1,500	—	3,400	—	4,200
,, 18 ...	750	6,000	—	—	720
,, 21 ...	1,400	200	2,000	—	1,500
,, 21 ...	Injected with vaccine (1,000,000,000 cocci)			—	—
,, 23 ...	700	5,000	200	1,020	20,000
,, 25 ...	2,000	—	30,000	3,200	30,000
Sept. 4 ...	—	38	525	nil	700
,, 6 ...	110	—	1,161	360	1,600
,, 8 ...	176	—	471	60	2,280
,, 11 ...	127	300	200	560	2,245
,, 15 ...	139	800	*	1,200	3,456
,, 15 ...	Injected with vaccine (1,000,000,000 cocci)			—	—
,, 18 ...	185	*	207	350	4,300
,, 20 ...	*	nil	320	560	5,280
,, 22 ...	nil	*	170	150	*
,, 25 ...	10	20	360	100	*
,, 27 ...	65	15	230	50	5,300

* Plates so contaminated as to be unworkable.

The initial dose of vaccine was 0·5 c.c., equivalent to 500,000,000 cocci, which was injected subcutaneously in the animal's flank. In the course of 12 hours or so the small local swelling caused by the injection had completely disappeared, the animal seemed to be in no way discommoded by the injection, and no marked rise of temperature took place. Within two or three days the agglutination value of both serum and milk fell in a most pronounced fashion, and on one occasion, in the case of Goat No. 114, disappeared altogether from the milk. Four or five days later the dilution in which the agglutination reaction could be obtained had again risen to a higher level than it had occupied previous to the injection of the vaccine—in short, the phenomena observed were exactly comparable to those noted in rabbits and guinea-

pigs under similar conditions.* The numerical strength of *M. melitensis* in the milk at first appeared to be as irregular and as erratic as before the treatment was commenced, but after a second injection of a somewhat larger dose of vaccine (1 c.c., or 1,000,000,000 cocci) 14 days after the first, the numbers underwent a certain diminution. Unfortunately, about this time the milk of another of the controls commenced to dry up, and within a month of the commencement of the experiment only small quantities of milky fluid could be obtained from this animal for examination. The Sheep No. 107, however, continued to yield a good supply of milk containing *M. melitensis* in undiminished numbers. These observations are being continued, for it is obvious that any method of treatment which would cause the destruction of the micrococcus in the infected goats and its disappearance from the milk would be a most valuable weapon in the hands of those who desire to stamp out Malta Fever from our Fleet and garrisons.

In the accompanying table (p. 43), which gives the number of cocci per cubic centimetre in the milk of the treated goats and in the controls, the diminution in the former may be readily followed.

II.—*M. melitensis* Infection by Experimental Feeding with Infective Goats' Milk.

1. *General Considerations.*

The experimental work undertaken by the Commission during the years 1904 and 1905 proved beyond question the possibility of producing a generalised infection in monkeys, goats, and kids as the result of feeding them upon articles of diet artificially contaminated with *M. melitensis*, although many of the earlier experiments were negative, and the value of some of the later positive experiments is depreciated owing to their lengthy duration, which affords opportunity for the introduction of numerous fallacies. For convenience of reference and comparison, these early experiments in the monkey dealing with infection *viâ* the alimentary system, have been tabulated (see pp. 46 and 47).

The method of experimentation that was adopted (*i.e.*, the repeated administration of contaminated food on successive or alternate days, often for long periods of time), combined with the difficulty of demonstrating the presence of *M. melitensis* on every occasion that supposedly contaminated articles of diet were administered, left many points of interest for further investigation.

Perhaps the most important of these was the question whether the administration of one quantum of contaminated food was sufficient to produce an *M. melitensis* infection *viâ* the alimentary tract, for, if so, the equally important question of the duration of the incubation period of the disease would necessarily be further elucidated.

* *Vide* these Reports, V, p. 44.

From the experiments tabulated below, it would at first sight be assumed that enormous doses of the virus are required to produce infection, and that the period of incubation, though varying within very wide limits—from 14 to 76 days—was usually a lengthy one; but a careful consideration of the various factors involved in those experiments is sufficient to show that such an assumption might well be fallacious, for the simple reason that the appearance of specific agglutinins in the blood serum was the criterion adopted as the evidence of infection. Now, it has already been shown elsewhere in these Reports (*vide* Part V, p. 45) that an animal inoculated with an excessively large dose of the micro-organism, or repeatedly injected with dead or with living cultures of *M. melitensis*, either fails altogether to elaborate specific agglutinins, or if such are present at the commencement of the experiment, fails to elaborate fresh supplies, whilst that previously stored in the serum is rapidly destroyed. An obvious explanation of the very lengthy incubation periods would therefore be that many of the animals to which repeated doses of *M. melitensis* were administered in the shape of daily supplies of food infected with the micro-organism, failed to form the specific agglutinins either until very late in the course of the infection, or until the temporary cessation of the "feeding," or the accidental absence of *M. melitensis* from the presumably infected food afforded the necessary respite, and allowed the response to the presence of the micro-organism to emerge from the negative into the positive phase. Again, the experimental inoculation of laboratory animals (*e.g.*, guinea-pigs, and particularly white rats) has shown that death frequently takes place when even a 1 in 10 agglutination reaction is absent and has been absent throughout the course of the infection, while the *post-mortem* examination reveals the fact that all the organs are teeming with the *M. melitensis.*

In support of this view, the case of Monkey No. 2 may be quoted (see Table XII). This animal was—with the exception of one day—fed continuously for 74 days with infective milk, and during this period no agglutination reaction could be obtained with the blood serum. The day following the cessation of the feeding, a very doubtful 1 in 10 reaction was obtained; nine days later the animal suddenly died, and at the *post-mortem* examination *M. melitensis* was recovered from spleen and from glands, although the blood serum still yielded merely an incomplete reaction with a 1 in 10 dilution.

These facts make it a matter of regret that the supply of animals for the early experiments was insufficient to allow of any considerable number being utilised for each experiment. Had it been possible to include more animals in certain of the experiments, so that some might have been killed and examined *post-mortem* during the course of the feeding, it would probably have been found quite frequently that infection had taken place at a very much earlier stage than was indicated by the appearance of the serum reaction.

Table XII.—Feeding Experiments 1904 and 1905.—Monkeys.

No. of experimental monkey.	Duration of "feeding" in days.	No. of "feeds."	Dose of *M. melitensis* at each feed.	Method of administration.	Evidence of infection. Presumptive. Appearance of serum reaction at	Value of serum.	Absolute. *M. melitensis* recovered from—	Observer.	Reference to volume and page of these Reports.
					days.				
39	32	28	1 agar slope	Culture from human spleen mashed with boiled potato	31	1 : 500	Spleen	H.	I, 50
40	33	28	"		32	1 : 10	Nil	H.	I, 53
113	13	12	?	Naturally infected urine (human) mixed with dust and dried, then sprinkled on food	—	—	Nil	H.	IV, 30
114	55	55	?		—	—	Nil	H. & K.	IV, 31
119	29	22	?		28	1 : 100	All organs	H.	IV, 35
120	29	29	?	Naturally infected urine (human) spread on potato	—	—	Nil	S.	V, 15
121	30	30	?		—	—	*		
26	134	39	?		—	—	*		
122	203	76	?	Naturally infected urine (human) mixed with dust and dried, then mashed up with potato	58	1 : 30	Kidney	S.	V. 16
30	69	63	?		—	—	Nil		
123	80	43	?	... ...	75	1 : 30	All organs		
124	29	29	1 agar slope	Culture from human spleen smeared on potato	13	1 : 30	Superficial glands only	S.	V, 17
125	29	29	"		28	1 : 40	Femoral and axillary glands		

126	29	29	,,	Culture from human urine smeared on potato	17	1 : 80	Nil	S.	V, 18
127	29	29	,,		28	1 : 120	Superficial and mesenteric glands		
2	74	73	?	Mixed milk from infected herd of 11 goats	74 ?	1 : 10	Spleen and glands	H. & K.	IV, 58
4	32	78	?		31	1 : 40	,,	H. & K.	IV, 56
5	30	70	?		29	1 : 10	,,	H. & K.	IV, 54
99	65	31	?	Variously with mixed milk from infected herd and whole milk from one of three infected goats	65	1 : 10	Mesenteric glands	H. & K.	IV, 59
6	24	8	1 agar slope	Culture from goat's milk mashed up with potato	31	1 : 10	All organs	H. & K.	IV, 48
7	24	9	,,		35	1 : 50	Spleen and glands	H. & K.	IV, 49
8	24	7	,,		25	1 : 10	Axillary, femoral and mesenteric glands	H. & K.	IV, 50
9	24	9	,,		25	1 : 10	Femoral and axillary glands	H. & K.	IV, 51
19A	2	2	,,	Culture from goat's milk emulsified	33	1 : 10	Spleen and glands	H. & K.	IV, 52

* No *post mortem* performed. H. = Horrocks. K. = Kennedy. S. = Shaw.

Basing a working hypothesis upon these considerations, and planning the experiments so that the results might yield the maximum of information, a considerable number of feeding experiments were performed, which for convenience of study are divided into six series. The main object of the experiments was to obtain exact information of the effects, if any, produced by the ingestion of a limited quantity of infective material; therefore it was determined to administer to each animal but one quantum of infected food, then, after a few days' interval, to commence testing the blood for the presence of agglutinins, and thenceforth to continue to apply this test on alternate days; and from the third week onwards to kill and examine *post-mortem* one or more animals each week. These experiments may now be described as follows :—

2. *Feeding with Naturally Infected Milk Artificially Reinforced.*

Series I.—Eight monkeys (*Macacus rhesus*) were employed in this experiment.

From the time of their arrival from Calcutta these animals were kept under observation at the Lazzaretto as to temperature and general condition, and were fed on soft food—boiled rice and boiled potato, together with sugar and water, and the blood serum from each repeatedly examined for *M. melitensis* agglutinins. The general condition being satisfactory, no lesions of the mucous membrane of the mouth, or of the skin of the face, hands, or feet being apparent to visual inspection, and specific agglutinins being absent from the blood, the monkeys were brought over to the laboratory at Valletta and arranged on the roof terraces. Each monkey was fastened in close proximity to a separate wooden cage by means of a chain, rather more than a metre in length, fastened at one end to a staple in the wall, and at the other to a ring in a leathern dog-collar secured around the animal's neck. Each monkey was separated from his neighbour on either side by a wooden partition, some 6 feet in height, projecting at right angles from the wall on which the cage was fastened for about 6 feet, and set in cement at its junction with both wall and pavement. By this means not only was personal contact between a monkey and its neighbour or neighbours rendered impossible, but the chance of contact with food or excrement other than its own was also obviated. In addition to the soft food previously mentioned, each monkey was supplied with about 250 c.c. of sterilised goats' milk per diem for three days. This they readily learned to lap up as they did water. On the fourth day they had the usual morning feed, together with sterilised milk at 8 a.m., but no more food was given that day. The following morning, May 13, 1906, the administration of infected food—goats' milk—took place. The infected milk employed in this

experiment was "mixed milk" derived from a herd of nine goats just received at the Lazzaretto from Rabato, five of which were known to be excreting *M. melitensis* in varying numbers in their milk, while the remainder were suspected of doing so on account of the agglutination reaction yielded by the milk, and the fact that *M. melitensis* had been isolated from the milk before they passed into the Commission's possession, although the micro-organism had not been recovered from the milk during their stay in the Lazzaretto up to the date of the experiment.

Having regard to the fact that any given milch goat shows great variations in the number of *M. melitensis* excreted in the milk even from day to day, a single agar slope culture of *M. melitensis* derived from the milk of Goat No. 104 was emulsified in sterile saline solution, and added to the two gallons of milk obtained from the infected herd. Plate cultivations were then prepared from the milk itself, and from various dilutions thereof, and after incubation at 37° C. for four days the colonies of *M. melitensis* which had developed were enumerated, and it was finally estimated that each cubic centimetre of the infected milk when supplied to the experimental monkeys contained 11,000,000,000 *M. melitensis*. That is to say, on this occasion, the milk contained *M. melitensis* to the number of about 10,000,000,000 per cubic centimetre *before the laboratory culture was added.*

The method of administration of the infective material was quite simple. As the monkeys were accustomed to receive sterilised milk as a regular article of the daily dietary, a small amount, 250 c.c., was supplied to each monkey in a clean pannikin at 9 a.m. From the laboratory window the animals were watched, and it was seen that each lapped up a certain quantity of the milk, in most cases small in amount, or, lifting up the pannikin, drank from it as one would from a cup before turning the receptacle upside down to ascertain whether other more solid food was concealed beneath. At 11.30 a.m. the pannikins were cleaned and a further 250 c.c. supplied to each animal, when the same performance was gone through. Each animal, in all probability, consumed 30 c.c. to 50 c.c. of the milk; certainly no animal ingested as much as 100 c.c. At 2 p.m. the usual feed of boiled rice was given, and from that time forward the ordinary meals were supplied and no more infected material was administered.

To serve as controls two healthy monkeys were each supplied with sterilised goats' milk in similar quantities, and as the two following series were carried out on the same day, they acted as controls for those also.

Six days after the administration of the infected milk a specimen of blood was taken from each monkey and tested for the presence of *M. melitensis* agglutinins. The result in each case was negative. This testing for the serum reaction was repeated thenceforth three or four times every week until the termination of the experiment. On the 10th day after feeding the first agglutination reaction was observed

(1 : 10); on the 12th day three other monkeys gave a good serum reaction in low dilutions (1 : 10, 1 : 20, and 1 : 20), while the first animal gave only an incomplete reaction in 1 : 10. On the 15th day three more monkeys reacted 1 : 10, 1 : 10, and 1 : 80 respectively, and on the 20th day the eighth monkey of the series yielded a 1 : 10 reaction. On this day also Monkeys Nos. 160 and 161 were chloroformed and autopsies performed, and in these, as in all *post-mortems* conducted in the laboratory, a thorough examination was carried out. In addition to the usual naked eye inspection, plate and tube cultivations were invariably established from the spleen, the axillary and inguinal glands, and at least four mesenteric glands; 10 cubic millimetres of blood taken directly from the heart were plated out, and a further supply of blood was collected for the purpose of determining the agglutinating value of the serum at the time of death.

Naked eye inspection of Monkeys Nos. 160 and 161 showed nothing beyond general glandular enlargement, and hypertrophy of the spleen, which was of a dark colour, hard and friable; but as the result of the bacterioscopic examination both these animals were found to harbour *M. melitensis* in the blood and in every organ examined.

Eight days later, that is four weeks from the day of feeding, one of the control monkeys was killed by chloroform and examined, but the result of the autopsy was completely negative. All the organs appeared normal, the blood serum possessed no agglutinating power whatever when tested against *M. melitensis*; nor could *M. melitensis* be demonstrated in any of the organs or tissues examined culturally. The second control was killed on the 36th day, and yielded identical results. Two more animals of this series were killed and autopsies performed on the 32nd day after feeding, the *M. melitensis* being recovered from one or more organs in each case, the spleen invariably yielding a growth of the micro-organism.

The full details of this experiment are tabulated below, while the net result may be summarised by saying that of eight experimental monkeys fed once on somewhat grossly infected milk, eight became infected by *M. melitensis* (as proved by results of *post-mortem* examination) after an incubation period varying from 10 to 20 days (as indicated by the date of appearance of the serum reaction).

Series II.—To contrast with the first series of animals, a further batch of similarly selected monkeys (from the same Indian consignment) were simultaneously prepared for feeding. In substitution for the rice and potatoes in the diet supplied to the animals in Series I, the monkeys in Series II received for the corresponding three days medlars, small Spanish nuts which they cracked between their teeth in order to get at the kernels, and hard roasted peas, the object being to afford the animals every opportunity of abrading the mucous membrane of the buccal cavity, and so facilitating the entrance of

Table XIII.—Feeding Experiments in 1906.—Series I.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction.		Duration of experiment in days.	Post-mortem findings.							
					Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from—						
									10 c.mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
162	♀	Two meals daily, comprising boiled potatoes, boiled rice, and sterilised milk, May 9, 10, and 11. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. infected goat's milk, containing 11,000,000,000 *M. melitensis* per c.c (Naturally infected goat's milk, reinforced by addition of 1 agar slope culture *M. melitensis*, derived from goat's milk, to 2 gals. of milk.)	Each monkey supplied with 250 c.c. of milk, in an open pannikin, at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13, 1906.	10	1 : 10	36	1 : 500	–	–	–	+	+	–	+
159	♂				12	1 : 10	36	1 : 200	–	–	–	–	–	–	+
160	♂				12	1 : 20	20	1 : 100	+	+	+	0	+	+	+
161	♂				12	1 : 20	20	1 : 50	+	+	+	+	+	+	+
163	♂				15	1 : 10	36	1 : 50	–	–	–	–	–	–	+
164	♂				15	1 : 20	36	1 : 200	+	+	+	+	+	+	+
165	♀				15	1 : 10	32	1 : 80	+	+	+	+	+	+	+
23	♀				20	1 : 10	32	1 : 600	+	+	+	+	+	+	+
Controls. 150	♂		About 50 c.c. sterilised goat's milk		–	–	36	–	–	–		–		–	–
172	♀				–	–	28	–	–	–		–		–	–

M. melitensis—converting, in fact, the feeding experiment into a subcutaneous inoculation, and imitating that condition of the mouth which must be frequently present in human subjects resident within the endemic area of Mediterranean Fever—in the anticipation that earlier infection associated with severer constitutional symptoms would sufficiently indicate that the desired end had been attained. Anxiety to ensure the ingestion of the infected food appears, however, to have caused the failure of this portion of the experiment, for the monkeys in Series II received their last lot of nuts and peas on the morning of May 12, and, like the animals in Series I, received no more food until the infected milk was placed before them 24 hours later, by which time any small abrasion caused by cracking nuts would, most probably, have been sealed off from contact with the contents of the mouth by a protective coating of serum.

Of this batch the first monkey gave a serum reaction of 1 : 10 on the 12th day after feeding with infected milk, four reacted for the first time on the 15th day and two more on the 20th day. One cubic centimetre of blood was abstracted from the external saphenous vein (by means of a small serum syringe) of Monkey No. 157 on the 18th day after feeding, and planted into 20 c.c. of broth. After three days' incubation at 37° C. of this first broth reinforcement, plate cultures therefrom yielded a pure culture of *M. melitensis.* Six of the remaining monkeys were killed on the 21st, 32nd, 36th, and 37th days after feeding, and cultural examination of the various organs specified in connection with Series I yielded abundant evidence of generalised infection by *M. melitensis.*

The eighth animal of Series II alone remains to be accounted for. This monkey gave a not quite complete reaction in a dilution of 1 : 10 on the 10th day after feeding; on the 35th day a similar reaction in 1 : 40 dilution.

It was killed by chloroform vapour on June 25, when it gave similar, not absolutely complete, reactions in all dilutions up to 1 : 40. At the autopsy general glandular enlargement of the axillary and inguinal glands was noted, associated with visible distention of the superficial lymphatics. The mesenteric glands were enlarged—some purulent, others caseous, and coverslip film preparations from both varieties, stained by the Ziehl-Neelsen method, showed the presence of acid-fast bacilli morphologically indistinguishable from *B. tuberculosis.* The spleen was large, dark, and friable, and studded all over with miliary tubercles; the lungs, liver, and kidneys appeared normal—the whole making a typical picture of early generalised tuberculosis. Cultivations from heart's blood, spleen, and the usual glands remained sterile up to the end of 10 days, when the period of observation of the cultivations was brought to a close. The most interesting point in this case was, of course, the pseudo-reaction that was obtained with

Table XIV.—Feeding Experiments in 1906.—Series II.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction.		Duration of experiment in days.	Post-mortem findings.							
					Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from— 10 c.mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
151	♀	Two meals daily, May 9, 10 and 11, consisting of peas, medlars, Spanish nuts, and sterilised milk. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. naturally infected "mixed" goat's milk reinforced by addition of 1 agar slope culture of *M. melitensis* (derived from goat's milk) to 2 gallons of milk.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13.	12	1 : 10	32	1 : 400	+	+	+	+	+	+	+
153	♂				15	1 : 40	37	1 : 4000	+	+	+	+	+	+	+
155	♂				15	1 : 10	36	1 : 1000	—	+	+	+	+	+	+
157	♂				15	1 : 40	*								
158	♂				15	1 : 10	37	1 : 1000	—	+	+	+	+	+	+
152	♂				20	1 : 10	37	1 : 3000	—	+	+	+	+	+	+
154	♂				20	1 : 40	21	1 : 40	—	+	+	+	+	+	+
156	♀				(15)	(1 : 10)	43	(1 : 40)	—	—	—	—	—	—	—
Controls. 172	♀		About 50 c.c. sterilised goat's milk		—	—	28	—	—	—	—	—	—	—	—
150	♂				—	—	36	—	—	—	—	—	—	—	—

* Still living. *M. melitensis* recovered from peripheral blood on 18th day. Serum reaction on 41st day, 1 : 1000.

the blood serum even up to a dilution of 1 : 40, and at once suggests an explanation of some of the anomalous reactions that are obtained with *M. melitensis* in cases of obscure fever in man.

All the essential details of this experiment (Series II) are tabulated (p. 53), the net result being that of eight experimental animals, one, suffering from *Tabes mesenterica*, was not infected with *M. melitensis*, the remaining seven became infected after an incubation period varying from 12 to 20 days, but presented no especial features as to severity, constitutional symptoms, or of febrile reaction or early appearance of serum reaction that would indicate that infection had taken place by a different path to that traversed in Series I.

This experiment, therefore, although successful in showing the possibility of infection by means of infected food, failed to differentiate between absorption through normal and injured mucous membrane.

Series III.—In a further attempt to investigate the factors involved in the infection through the alimentary system, a third batch of eight monkeys selected for the purpose in a manner similar to that adopted in the two former series were injected subcutaneously, each with 1 c.c. of *B. typhosus* vaccine, a few hours after the morning meal on May 12, with the object of producing a marked constitutional disturbance which should not have passed off by the time the milk infected with *M. melitensis* was administered.

This object was certainly attained—two of the animals in fact succumbed, one being dead on the following morning at 6 a.m., the second dying a few hours after the administration of the infected milk. The remaining six monkeys were clinically distinctly ill, although in no case did the temperature rise above 104° F., repeatedly drank small quantities of the infected milk and refused the rice supplied to them in the afternoon. The following day all were apparently well, and the local swelling marking the seat of injection of the vaccine disappeared completely in the course of a few days.

The results obtained were somewhat conflicting. One animal showed a serum reaction (1 : 10) on the 15th day, and an incomplete reaction (1 : 10) on the 20th day. The agglutinins then disappeared from the blood, and could not again be demonstrated until the 33rd day, when the reaction was obtained in a dilution of 1 : 20. Two more animals reacted on the 20th day, while the sixth, which showed no signs of the presence of agglutinins in the blood, was killed and examined *post-mortem* on the 24th day, after feeding showed absolutely no evidence of *M. melitensis* infection. In two only of the five animals that were infected was *M. melitensis* generalised throughout the body. In the remaining three it was recovered with difficulty—from the spleen alone in two and from the spleen and mesenteric glands in the third.

Despite the danger attending generalisations founded on insufficient premises, it would almost appear that the response of these animals to

the injection of *B. typhosus* vaccine had in some obscure manner enabled the majority of them to make a better fight against the invading *M. melitensis*, and to achieve a more rapid destruction of the organism, than any of their fellows who had not been so stimulated prior to the administration of the infected milk. The details of this experiment are given in the accompanying table (p. 56).

As these three series of feeding experiments were carried out simultaneously and under similar conditions of environment, the same two controls served for all, and the details concerning them will be found tabulated with those of the experimental monkeys in each series.

Having by these experiments shown that the ingestion of a small amount of somewhat heavily infected milk was sufficient to determine a *M. melitensis* infection after an incubation period varying from 10 to 20 days, it now remained to ascertain whether naturally infected milk—without reinforcement by the addition of laboratory cultivation —would suffice to yield a like result, and to this end further sets of experiments were initiated. Before detailing these, however, some comment is necessary on the two possible sources of fallacy which may be urged against the foregoing experiments, viz. :—

(A) Infection conveyed by means of mosquitoes and biting flies.

(B) "Place" infection—by reason of the fact that during the last two and a-half years each and all of the wooden cages had been inhabited at various times by infected monkeys, and were, therefore, possibly more or less contaminated with infective excrement.

Dealing first with (A), it should be noted that during April,* May,† and the early part of June,‡ 1906, an exceptionally cold spell of weather prevailed throughout the island, a few Culex (of the common species, fatigans and pipiens) were observed and caught inside houses, but neither they nor Acartomyia or Stegomyia appeared in the Laboratory or on the terrace until long after many of the experimental animals had given unmistakable evidence of the infection. Flies also were conspicuous by their absence; Stomoxys was not observed upon the terraces during these experiments, and it was not until well on in June that it could be obtained, even from stables, in quantities sufficient for experimental work. These points, however, are by themselves insufficient to absolutely negative the objection raised under heading (A).

In the succeeding experiments further precautions were taken for the express purpose of eliminating the possibility of infection through the

* April, 1906, was the coldest April in the five years 1902—1906, with 26 days in defect of the average for the five-year period.

† May, 1906, was the coldest May in the five years 1902—1906, with 20 days in defect of the average for the five-year period,

‡ June, 1906, was the coldest June in the five years 1902—1906, with 20 days in defect of the average for the five-year period.

Table XV.—Feeding Experiments in 1906.—Series III.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction. Day of appearance.	Serum reaction. Amount of dilution.	Duration of experiment in days.	Post-mortem findings. Value of serum.	*M. melitensis* recovered from— 10 c mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
36	♂	Two meals daily, May 9, 10 and 11, consisting of boiled potatoes, boiled rice and sterilised milk. One similar meal at 8 A.M., May 12.	Not more than 50 c.c. naturally infected "mixed" goat's milk reinforced by the addition of 1 agar slope. Culture of *M. melitensis* (derived from goat's milk) to 2 gallons of milk.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. of same milk at 11.30 A.M., May 13.	10	1 : 20	43	1 : 40	—	—	—	—	—	+	+
171	♀				12	1 : 20	29	1 : 40	+	+	+	+	+	+	+
168	♂				15	1 : 10	43	1 : 20	—	—	—	—	—	—	+
166	♀				20	1 : 10	43	1 : 50	—	—	—	—	—	—	+
170	♂				20	1 : 10	32	1 : 250	+	+	+	+	+	+	+
167	♂				—	—	24	—	—	—	—	—	—	—	—
Controls. 172	♀		About 50 c.c. sterilised milk.		—	—	28	—	—	—	—	—	—	—	—
150	♂				—	—	36	—	—	—	—	—	—	—	—

agency of insects. The animals employed were selected from a consignment of monkeys that arrived in Malta from Calcutta early in July. On their arrival at the Lazzaretto they were placed in mosquito- and fly-proof rooms where they remained until their transference to the Laboratory terraces. Here they were allotted sleeping boxes, each of which was accommodated in a separate cubicle similar to those employed in the first three experiments, but rendered mosquito- and fly-proof by roofing with wood, fronting with a gauze covered framework with hanging door, and caulking all joints and cracks in the woodwork with putty, or pasting them over with stout paper.

With reference to the possibility of infection having taken place through contact with the excrement-polluted woodwork of the sleeping boxes, it may be stated that before allotting a box to a normal monkey, it was first scraped clean, then thoroughly scrubbed inside and out with a 2-per-cent. solution of Lysol, and the wood saturated with the same; then the box was dried in the sun. When thoroughly dry, it was again scrubbed with a fairly strong solution of caustic soda until the wood had regained its pristine whiteness, and no stain or discoloration was visible, well rinsed first with plain water, then with the Lysol solution, and finally exposed to the direct rays of the sun for a day or two.

The cubicle in which the box was to be fitted was thoroughly disinfected by washing down walls and partitions with the Lysol solution (sprayed on by means of a garden squirt), and as the terrace floors are entirely of cement, the same treatment was extended to them.

Finally the two controls and two of the experimental animals failed to contract the disease, and would thus appear to afford proof of the efficacy of the disinfectant measures pursued.

3. *Feeding Experiments with Naturally Infected Milk Alone.*

Series IV.—The same care was observed as in the earlier experiments in picking out animals that were in good general condition, free from cuts and scratches, and from whose blood serum specific agglutinins were absent. The method of preparation for the feeding experiments was identical with that adopted in Series I, and the infective material was again goats' milk derived from the herd of goats under observation at the Lazzaretto. In addition, the monkeys employed in this and the succeeding series had been trained to drink milk from the pannikin "human fashion."

In the fourth set of experiments two monkeys only were employed, and these were each supplied with 500 c.c. of "whole" milk (in two equal quantities as in the previous experiments, the first at 9 A.M., the second at 11 A.M.), the one from Goat No. 114, the other from

Goat No. 115, in order to imitate, as far as possible, the sequence of events taking place in a private household, where the housewife calls to a passing goatherd and receives into the receptacle she provides the milk from one goat for consumption by the family. Each of the goats above-mentioned had been under observation for some months, and was consistently passing *M. melitensis* in its milk. Samples of each of these milks were diluted and plated, and on enumeration after incubation it was found that the milk from Goat No. 114 contained 800 *M. melitensis* per cubic centimetre, and that from Goat No. 115, 300 per cubic centimetre.

The milk was set before the experimental monkeys in pannikins, as in the three former experiments, but, as the animals were shut up in mosquito-proof cubicles, it was difficult to ascertain how much, if any, of the milk had been consumed. With regard to Monkey No. 197, however, it is certain that she ingested at any rate 45 c.c. of the milk from Goat No. 114, as owing to a mistake on the part of an assistant she was anæsthetised during the morning, and a soft rubber catheter passed into her stomach before the error was noticed. Under the circumstances it was deemed advisable to introduce a further dose of the milk she had presumably drunk earlier in the day into her stomach before allowing her to recover from the anæsthetic, and this was accordingly done. Monkey No. 196, on the other hand, only ingested such quantity of milk as she had voluntarily drunk from her pannikin.

Two monkeys which served as "controls" for this and the two following series each received 500 c.c., and consumed about 50 c.c. of sterilised goats' milk.

Of the two animals fed on infected whole milk, Monkey No. 197, which must certainly have received a larger dose of infected milk, and milk moreover which contained at least double the number of cocci per cubic centimetre, showed a definite reaction four days before her fellow sufferer, that is on the 17th day, Monkey No. 196 showing a definite reaction on the 21st day. Exactly one month after feeding, Monkey No. 197 and one of the controls, 189, were chloroformed and careful examinations made of the bodies, with the result that no evidence of infection by *M. melitensis* could be obtained in the case of the control, whilst Monkey No. 197 yielded *M. melitensis* from all the organs examined, although the coccus was absent from the small quantity of heart blood that was plated.

The Monkey No. 196 was chloroformed on the 33rd day, when the blood serum gave an immediate and unmistakable positive reaction in dilutions of 1 in 100. The *post-mortem* examination showed greatly enlarged liver and spleen, each organ being studded with tubercles, many of which were caseous. The superficial lymphatic glands were also enlarged. Cultivations established from the blood and the organs gave rise to a plentiful growth of various bacteria, but no *M. melitensis*

Table XVI.—Feeding Experiments in 1906.—Series IV.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.							
					Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from— 10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
197	♀	Two meals daily, July 23, 24, and 25, consisting of boiled rice and sterilised milk. One similar meal at 8 A.M. July 26.	Infected "whole" milk (Goat No. 114), 800 *M. melitensis* per c.c.	Each monkey supplied with 250 c.c. of its corresponding milk (see previous column) in open pannikin at 9 A.M., and a further 250 c.c. of milk at 11 A.M. July 27.	17	1 : 10	28	1 : 50	—	+	+	+	+	+	+
196	♀		Infected "whole" milk (Goat No. 115), 300 *M. melitensis* per c.c.		21	1 : 10	33	1 : 100	—	*	*	*	*	*	*
Controls. 189	♂		Sterilised milk mixed (Goats No. 114 and 115).		—	—	28	—	—	—	—	—	—	—	—
190	♀				—	—	48	—	—	—	—	—	—	—	—

* Enlarged and tuberculous.

could be detected or recovered. While in this case there is not a shadow of doubt in the minds of the experimenters that the monkey had been successfully infected, the coexistence of abdominal tuberculosis had exercised such a profound influence on the course of the disease as to render the absolute proof of the existence of infection, viz., the recovery of *M. melitensis* from the various organs *post mortem* impossible to obtain, and this animal must consequently be eliminated from the experiment.

The second control, which was killed on the 48th day, showed no signs *post mortem* of infection with *M. melitensis* and at no period during the course of the experiment could specific agglutinins be detected in its blood serum.

The net result of this experiment, however, is still to conclusively prove that infection may result in the monkey (*e.g.*, No. 197), after the ingestion of one quantum of naturally infected milk, and that not a grossly contaminated sample, with an incubation period of about 17 days.

Series V.—In the next experiment an attempt was made to reproduce the conditions obtaining in the case of a hospital, barracks or other large institution supplied with goats' milk by a contractor who would necessarily command the daily milkings of a large number of goats and who would, for the convenience of all parties, supply "mixed" milk in churns of several gallons capacity.

Experience based upon the examination of the milch goats in a large number of herds from all parts of the island had already shown that a typical herd consisted of something like 60 per cent. normal goats yielding milk free from contamination with *M. melitensis*; 30 per cent. of goats previously infected (and whose milk yields a definite agglutination reaction), but which are either completely convalescent or else are in an early stage of the disease and are consequently not discharging the specific micro-organism in the milk; and 10 per cent. of goats whose milk not only gives a strong agglutination reaction, but also contains *M. melitensis* in varying numbers.

The infective material in this experiment was consequently made up in the following manner:—

Three perfectly healthy goats which gave no evidence of having been infected with *M. melitensis* were milked to the extent of 1 litre each into a sterile bottle.

Goats Nos. 101, 108, 110, whose milk gave a good agglutination reaction, but although plated regularly several times a week for some months had never yet yielded *M. melitensis*, were milked, also in sterile bottles, to the extent of 500 c.c. each. Goat No. 117, whose milk gave a good agglutination reaction and invariably yielded *M. melitensis* when plated, in numbers ranging from a few hundreds to thirty thousand and upwards per cubic centimetre, was milked to the extent of 500 c.c. into another sterile bottle.

Taking 500 c.c. as the unit of measurement, two volumes of milk from each of the three first goats were mixed with one volume from each of Goats Nos. 101, 108, 110 and 117, thus forming a fairly representative "mixed" milk such as would be obtained from an average herd.

Before the mixing was actually carried out, centrifugalised samples or suitable dilutions from the milk of each goat were plated out, and after the usual period of incubation and observation the following results were obtained:—

Goat 117.	Agglutination	reaction	positive.	Contained approximately 1000 *M. melitensis* per c.c.	
" 101.	"	"	"	Contained no *M. melitensis*.	
" 108.	"	"	"	"	"
" 110.	"	"	"	"	"
" 2.	"	"	negative	"	"
" 3.	"	"	"	"	"
" 8.	"	"	"	"	"

Samples of the "mixed" milk plated after mixing gave an average of 100 *M. melitensis* per cubic centimetre.

Two hundred and fifty cubic centimetres of this "mixed" milk were supplied to each of five experimental monkeys at 9 A.M. It was impossible, however, to see what was going on inside the mosquito-proof cubicles and, as much of the milk was wilfully wasted by the animals, a further quantity of 250 c.c. was filled into each monkey's pannikin at 11 A.M. At one o'clock the pannikins were removed, sterilised and refilled with a feed of boiled rice. From this point onwards the ordinary method of feeding was resumed and no more infective material was administered.

Of this batch of five animals, one (191) was found a few days after the feeding to be prostrate and helpless. It refused all food, ran a markedly intermittent temperature, and was found dead on the 10th morning. No serum reaction had been exhibited by this animal during its lifetime, and *post-mortem* examination failed to reveal infection by *M. melitensis*, or indeed any obvious cause for death. This animal must consequently be disregarded and is not included in the table dealing with this experiment.

Of the remainder, Monkey No. 195 first yielded a positive serum reaction (1 : 10) on the 17th day, Monkey No. 194 on the 18th day and Monkey No. 192 on the 21st day. The first Monkey (No. 195) pursued a remarkable course. From the 17th day onwards the dilution in which the serum reaction was obtainable steadily rose until on the 25th day it had reached 1 in 100. At the end of the third week blood was extracted from the external saphenous vein of each of the monkeys comprised in Series IV, V, and VI and planted in broth. Two days later all the tubes were found to be badly contaminated, with the

Table XVII.—Feeding Experiments in 1906.—Series V.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective material.	Method of administration.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.							
					Day of appearance.	Amount of dilution.		Value of serum.	*M. melitensis* recovered from—						
									10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
195	♀	Two meals daily, July 23, 24 and 25, consisting of boiled potatoes, boiled rice and sterilised milk. One similar meal at 8 A.M., July 26.	Not more than 50 c.c. of mixed milk from healthy and infected goats (Nos. 102, 103, 118, 101, 108, 110, and 117) containing 100 *M. melitensis* per c.c.	Each monkey supplied with 250 c.c. milk in an open pannikin at 9 A.M., and a further 250 c.c. at 11 A.M., July 27.	17	1 : 20	38	*	†	—	—	—	—	—	—
194	♀				18	1 : 10	31	1 : 50	+	—	—	—	—	—	+
192	♀				21	1 : 10	33	1 : 100	—	+	+	+	+	+	+
193	♂				—	—	48	—	—	—	—	—	—	—	—
Controls. 189	♂		About 50 c.c. sterilised goat's milk.		—	—	28	—	—	—	—	—	—	—	—
190	♀				—	—	48	—	—	—	—	—	—	—	—

* On the 25th day the serum from this monkey gave a positive reaction with a dilution of 1 in 100.
† On the 21st day the blood from this monkey yielded *M. melitensis* in small numbers.

exception of those planted with blood from Monkey No. 195. These tubes were plated out and yielded a scanty growth of *M. melitensis*. The serum reaction then fell rapidly and on the 32nd day an incomplete reaction was all that could be obtained with 1 : 20 dilution. When killed on the 38th day agglutinins appeared to be absent from the blood serum, as no reaction could be obtained even with 1 : 10 solution. Cultivations from the various organs remained sterile and the non-recovery of *M. melitensis*, *post-mortem*, would appear to indicate that the infection was of a very mild and transitory type.

Another Monkey (No. 193) showed no sign whatever of infection throughout the course of the experiment, no trace even of agglutinin was present in its blood serum up to the date of the termination of the experiment on the 48th day, when it was chloroformed and examined *post-mortem*. *M. melitensis* was not recovered from any of its organs. It is, of course, possible, but not probable, that the monkey refused to take any of the infected milk and the absence of infection may be due to this cause, or to absolute continuity of the mucous membrane of the upper portion of the alimentary tract, but these are pure speculations. The fact remains that this monkey did not become infected by *M. melitensis*.

The two remaining monkeys (Nos. 194 and 192) when killed on the 31st and 33rd days respectively, afforded abundant evidence of generalised infection, so that as the net result of this experiment it may be stated that three out of four monkeys became infected as the result of each ingesting a quantity of mixed milk, containing not more than 5000 *M. melitensis*.

The full details of the results obtained are given in tabular form (p. 62).

Series VI.—As in all the preceding experiments, it may be urged that infection took place not through the intact mucous membrane of the alimentary canal, but through some lesion, perhaps only microscopic in extent, of the mucous membrane of the mouth; in this experiment an attempt was made to differentiate between such and direct absorption through the presumably intact mucous membrane of the stomach and intestinal walls. Two monkeys were, therefore, selected and prepared for the experiment in a manner precisely similar to that adopted in the other experiments; Monkey No. 198 was carefully anæsthetised with an A.C.E. mixture (alcohol, 1 part; chloroform, 3 parts; ether, 6 parts) and when fully unconscious, his mouth gently opened and a wooden gag introduced and fixed behind the canine teeth. The tongue was then pulled forward and a No. 8 soft rubber catheter passed down the œsophagus into the stomach. A small funnel was inserted into the open end of the catheter and 45 c.c. of "whole" milk from Goat No. 117, containing 1000 *M. melitensis* per cubic centimetre poured through into the stomach. Half a minute later the catheter was washed through with 10 c.c. of sterile salt solution, and after another short interval the

Table XVIII.—Feeding Experiments in 1906.—Series VI.

No. of monkey.	Sex.	Preparation for feeding.	Dose of infective materials.	Method of administration.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.							
									M. melitensis recovered from—						
					Day of appearance.	Amount of dilution.		Value of serum.	10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
198	♂	Two meals daily, July 23, 24, and 25, consisting of boiled potatoes, boiled rice, and sterilised milk. One similar meal at 8 A.M. July 26.	45 c.c. infected milk from Goat No. 117, containing 1000 *M. melitensis* per c.c.	Through soft rubber catheter passed into stomach under an anæsthetic.	—	—	42	—	—	—	—	—	—	—	—
199	♂		45 c.c. infected milk from Goat No. 117, containing 4000 *M. melitensis* per c.c.		—	—	42	—	—	—	—	—	—	—	—
Controls. 189	♂		About 50 c.c. each of sterilised goat's milk.	*Vide* Table XVII	—	—	28	—	—	—	—	—	—	—	—
190	♀				—	—	48	—	—	—	—	—	—	—	—

open end of the catheter was clipped and the instrument carefully withdrawn. On removing the pressure from the upper end of the catheter nothing but a few drops of clear saline solution flowed from the eye. The animal was kept under the influence of the anæsthetic for a further period of five minutes, then gradually allowed to come to. No regurgitation of milk took place and the monkey was soon sufficiently recovered to be returned to his cubicle. By similar means, Monkey No. 199 had 45 c.c. of whole milk from Goat No. 111, containing 4000 *M. melitensis* per cubic centimetre introduced into his stomach and in this instance also regurgitation of the food was absent.

Of these two animals, Monkey No. 199, which had received some 180,000 *M. melitensis*, showed no signs of the formation of specific agglutinins throughout the entire course of the experiment, and when killed and examined *post-mortem* on the 42nd day the cultivations prepared from the various organs remained sterile. Monkey No. 198, which had received 45,000 *M. militensis*, yielded on the 17th day a very incomplete reaction with 1 in 10 solution of blood serum. A similar incomplete reaction was noted in the same dilution on the 21st and 25th days. No further reaction was obtainable, and when the animal was killed on the 42nd day, the cultivations prepared from the various organs—like those from Monkey No. 199—remained sterile. This experiment therefore yielded completely negative results. In neither case did the introduction of fairly large numbers of *M. melitensis* into the stomach direct—avoiding any contact with the mucous membrane of the upper portion of the alimentary canal—result in the infection of the experimental animal. As the experiments comprised in Series IV, V, and VI were carried out on the same day and under exactly comparable conditions, Monkeys No. 189 and 190 have done duty as controls to all.

The details of this experiment are shown in Table XVIII (p. 64).

4. *Clinical Features of Food Infections in the Monkey.*

On the clinical aspect of the infection produced by these feeding experiments it is unnecessary to dwell at length or to reproduce temperature charts in detail. A few points of interest may, however, be briefly mentioned :—

Temperature.—Speaking generally, the infection, as judged by the course of the animal's temperature and supported by its general appearance and behaviour, appeared to be far from severe during the six or seven weeks some of the animals were under observation, but opinions based upon clinical symptoms were rudely contradicted by the result of the *post-mortem* examinations.

In this connection it is necessary to emphasise the ready response of the temperature of the monkey to environmental conditions. The normal temperature of the Rhesus when confined in the cool, quiet

rooms of the Lazzaretto and attended by a man accustomed to handle such animals and thoroughly acquainted with their habits, averages about 101° F., although such extremes as 99°·2 in the morning and 103°·4 in the evening have been noted. (The temperatures are here given in Fahrenheit degrees for the sake of uniformity with the temperature charts recorded in previous parts of these Reports.) When transferred to the hot, sunny terraces outside the Laboratory—overlooking, perhaps, the noisiest street in Valletta—and handled by a new and ignorant attendant, who at first obviously went in fear of his charges, the normal temperature became probably half a degree higher. When, as sometimes happened, the animal was allowed to resist capture and to struggle for some minutes before it was sufficiently firmly held to allow of its temperature being taken, the resulting reading was sometimes as much as 2° F. too high. Under such conditions as these, febrile temperatures are apt to be fallacious unless very rigorously scrutinised, and to illustrate these irregularities of the temperature curve, the chart of one of the normal healthy controls—Monkey No. 172—may be utilised.

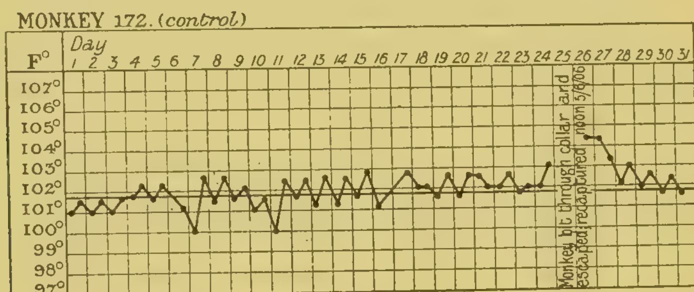


Chart 6.

Another point to be noted with regard to the even temperatures many of the experimental monkeys exhibited, is that, owing no doubt to the strictly enforced cleanliness of the monkeys and their habitations, and the minute attention devoted to the quality of their food, the cases were uncomplicated by diarrhœa and gastro-intestinal disturbances, which are, perhaps, the most fruitful causes of febrile reaction in the monkey.

Again, speaking generally, the temperature chart of the Rhesus infected with *M. melitensis*, except in the case of very severe infections such as follow intercranial injections of the micrococcus, shows but one period of pyrexia, followed by an intermittent temperature of slight range and short duration. A second period of pyrexia, or "wave" as it is colloquially termed, is quite the exception. The remittent type of pyrexia does, however, occur in the monkey; also this animal sometimes exhibits a type of temperature absolutely comparable to the one obtaining in man, when the subject of what Shaw has designated the "ambulatory" type of Mediterranean Fever.

Turning now to concrete examples, the temperature charts of Monkeys Nos. 153, 164, and 155 have been selected to illustrate the three types above referred to, and, although varying so widely in clinical aspect, the severity of the infection must have been of nearly equal intensity in these cases, judging by the results of the bacterioscopic examination, which showed that the blood and all the organs of these animals were literally teeming with the *M. melitensis*.

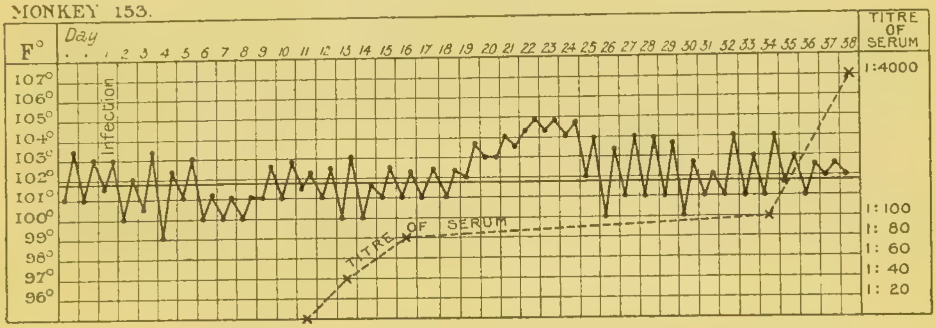


Chart 7.

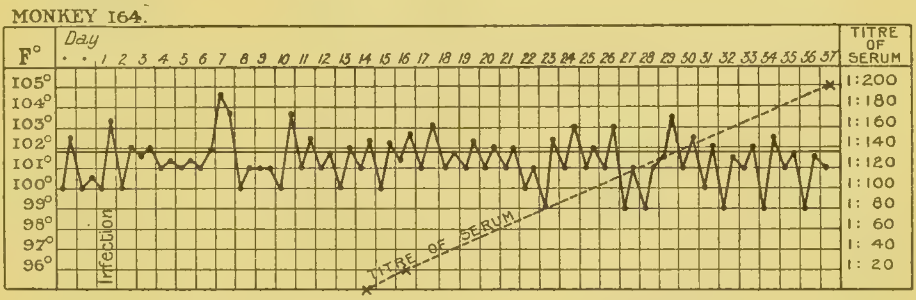


Chart 8.

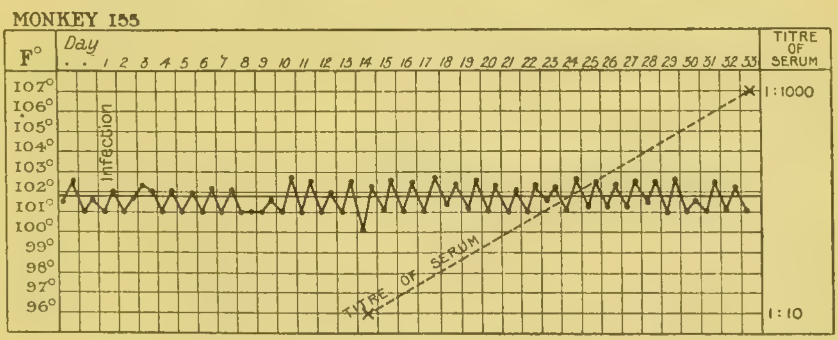


Chart 9.

Agglutination Reaction.—The repeated examinations that were made of blood from each of the infected monkeys showed that for a day or two, or even several days, before a definite reaction was obtainable, a 1 : 10 dilution of the serum produced what is regarded as an "incomplete"

reaction—that is, the micrococci ceased to exhibit active vibratory movement and adhered together in small bunches, but large clumps and masses were not formed and the general field was made up of discrete cocci. Then a good reaction, large clumps in a perfectly clear fluid, readily visible with the two-thirds lens or, indeed, the unaided eye, would be produced by a low dilution of the serum—1 : 10 or 1 : 20. Very often, even at this stage, the macroscopical reaction in the sedimentation tube was absent. Next, the microscopical reaction would often disappear for a day or two, or even longer; finally, it would become firmly established and obtainable in the majority of cases in considerably higher dilutions, and the micro- and macroscopical reactions would control and confirm each other with absolute precision. The exigencies of experiment necessitating the destruction of animals early in the course of the disease are responsible for the fact that but few examples of the development of a very high agglutinative power in the serum were noted.

5. *The Action of Hydrochloric Acid and of Artificial Gastric Juice on* M. melitensis.

During the progress of these experiments, an investigation into the action of hydrochloric acid alone and also of artificial gastric juice upon the *M. melitensis* was undertaken. In the first instance, 1-per-cent. solution of hydrochloric acid to the amount of 5 c.c. was mixed in a sterile test-tube with a like volume of emulsion, in normal saline solution, of cultivation of *M. melitensis*, the emulsion being approximately of the strength of 1 milligramme of cultivation to 100 c.c. of saline solution, or, expressed in individual cocci, about 2,000,000 of *M. melitensis* per cubic centimetre; 5 c.c. of the emulsion mixed with an equal quantity of 0·10 per cent. hydrochloric acid were put up in a second tube, 5 c.c. of the emulsion of *M. melitensis* mixed with an equal quantity of 0·05 per cent. hydrochloric acid solution were put up in a third tube, and a control was prepared by mixing 5 c.c. of normal saline solution with 5 c.c. of the emulsion in a fourth tube. Immediately after mixing, a loopful of the contents of each tube was plated out and the tubes transferred to the incubator at 37° C. At intervals of 5, 10, 15, 20, and 30 minutes, and also after one and two hours' incubation, further similar plates were prepared from the mixture in each tube, and, after the usual period of incubation and observation, each of the plates was carefully studied. Many variations were made in the percentage strength of the hydrochloric acid solution and in the number of cocci per cubic centimetre of the emulsion, and the mixtures were similarly tested. The results obtained were fairly uniform and showed that when the very large numbers of cocci were suspended in weak solution of the acid, very little lethal action was demonstrable.

On the other hand, it will be seen from the experiment tabulated

below, which is a typical one, that *M. melitensis*, when present in an aqueous solution of the acid in moderate numbers only, while able to withstand the lethal action of a 0·025-per-cent. solution of hydrochloric acid as well as of 0·05-per-cent. solution for considerable periods, is destroyed by 0·5-per-cent. solutions within an hour :—

Table XIX.—The Action of HCl upon Watery Suspensions of *M. melitensis.*

Composition of mixture :— Bacterial emulsion and solution of HCl.	Percentage of HCl in mixture.	Time of contact.			
		Immediately.	45 mins.	60 mins.	2 hrs.
5 c.c. + 5 c.c. of 1 per cent.	0·5	+	±	–	–
5 c.c. + 5 c.c. of 0·1 per cent.	0·05	+	+	+	±
5 c.c. + 5 c.c. of 0·05 per cent.	0·025	+	+	+	+
Control.					
5 c.c. emulsion of cocci + 5 c.c. of saline solution	–	+	+	+	+

+ = Good growth, ± = Scanty growth, – = No growth.

Next, a couple of sterile flasks were taken and 25 c.c. of milk from Goat No. 115, containing some 2500 *M. melitensis* per cubic centimetre, was introduced into the interior of one, and 25 c.c. of artificial gastric juice added and thoroughly mixed. The composition of the artificial gastric juice was :—

Pepsin	0·32 gramme
Hydrochloric acid..................	0·02 ,,
Sodium chloride	0·22 ,,
Sterile distilled water	100 c.c.

A control was formed by mixing 25 c.c. of milk from Goat No. 115 and sterile saline solution.

After plating a loopful from each mixture to determine the number of micrococci present at the commencement of the experiment, the flasks were placed in the incubator at 37° C. At 15, 30, 60 minutes, 2 and 24 hours, the flasks were removed from the incubator and about one-tenth of a cubic centimetre from the contents of each plated out, and after incubation the colonies of *M. melitensis* which developed were enumerated.

One of the experiments—a representative one—is tabulated below, and shows that the artificial gastric juice exerts some, although slight, inhibitory action on the growth of *M. melitensis* from the moment of contact.

Table XX.—The Action of Artificial Gastric Juice upon *M. melitensis* present in Naturally Infected Milk.

Mixture.	Time of contact.				
	Immediately.	15 mins.	30 mins.	60 mins.	2 hrs.
25 c.c. artificial gastric juice + 25 c.c. milk from Goat No. 115	420	640	130	250	440
Control.					
25 c.c. normal saline solution + 25 c.c. milk from Goat No. 115	1390	850	2700	1890	3050

The numbers give the calculated yield of *M. melitensis* per cubic centimetre.

III.—*M. melitensis* Infection following the Ingestion of Infective Milk in Man.

As an interesting and highly instructive corollary to the foregoing infections in the monkey, resulting from experimental feeding with infective milk, the occurrence of an epidemic of Malta Fever on board the s.s. "Joshua Nicholson," a cargo steamer, which conveyed a herd of milch goats from Malta to Antwerp towards the end of the summer of 1905, may be cited. Many of the officers and crew partook of the milk of these goats, and subsequent bacteriological investigations proved that some of these animals were infected by *M. melitensis*. As a result of the investigations made at the end of 1905 and during 1906, there can be no reasonable doubt that the cases of Malta Fever reported from the ship were due to the ingestion of the infected milk.

The history of the outbreak has been carefully compiled by Staff-Surgeon Clayton, and full epidemiological details, together with the history of each individual case so far as can be ascertained, is presented in a succeeding Part of these Reports, but because the history, read in the light of the results recorded in the previous section, savours so strongly of a carefully planned laboratory experiment, a short *résumé* is inserted here.

Résumé of the Outbreak of Mediterranean Fever on Board the s.s. "Joshua Nicholson."

1. *History of the Goats.*

Mr. Thompson, of the United States Bureau of Animal Industry, visited Malta in the summer of 1905, and during a stay of some

months gradually purchased a herd of 61 milch goats (all healthy in appearance and good milkers, many being prize animals), and four billy goats. These he shipped on board the cargo steamer "Joshua Nicholson," on August 19, 1905, for passage to the United States *viâ* Antwerp. During the voyage, which lasted until September 2, 1906, when Antwerp was reached, the goats were milking well, and many of the ship's company partook freely of the milk—the officers drinking "mixed" milk collected in a large vessel, the members of the crew each obtaining "whole" milk from one goat in his own separate pannikin.

On arrival at Antwerp the goats were at once transferred to the quarantine station, where they remained for the five days that elapsed before they were re-embarked on the s.s. "St. Andrew" bound for New York, and during this voyage a large quantity of milk was again available for consumption. New York was reached about September 24, and the animals were transferred to the quarantine station at Athenia, N.J., where they remained under observation. Subsequent bacteriological examination resulted in the recovery of *M. melitensis* first from the milk of two of the goats and afterwards from that of several more.

2. *The Incidence of Mediterranean Fever among those who partook of the Milk.*

(a) *In the s.s. "Joshua Nicholson."*—In addition to four passengers (Mr. Thompson and three goatherds) present on the voyage from Malta to Antwerp, the "Joshua Nicholson" carried 23 officers and men. Of the crew of 19, the carpenter, boatswain, and mess-room steward, together with eight others (11 in all), left the ship at Antwerp; the boatswain was afterwards in hospital suffering from hernia; the movements of the remainder cannot be traced. Of the 12 remaining officers and crew, eight fell sick at intervals varying from 18 to 34 days from the embarkation of the goats, and in the cases of five of these eight the blood reactions leave no room for doubt that Mediterranean Fever was the cause of their illness.

The four members of the ship's strength who did not show any signs of illness were the second mate and the cabin boy, with whom the milk disagreed and who consequently had but very little, and two engineers (Germans) who drank the milk, it is true, but appear to have always boiled it.

Of the three goatherds, one (the chief goatherd) had undoubtedly been infected with *M. melitensis* previous to July, 1906, as evidenced by the presence of specific agglutinins in his blood, but whether recently or remotely it was impossible to say: about the two assistant goatherds no information could be obtained.

(b) *At Antwerp.*—The staff of the quarantine station and many

individuals in the neighbourhood are said to have partaken of the milk, both raw and boiled, during the five days the goats were interned here, but no information can be obtained of the subsequent occurrence of cases of illness resembling Mediterranean Fever.

(c) *In the s.s. "St. Andrew."*—The s.s. "St. Andrew" carried 30 cattle men and the three goatherds and Mr. Thompson, in addition to a crew of 30 men. Most of these drank of the milk, but the master of the ship and also his owners state that none of the men suffered from any illness.

(d) *In America.*—With the exception of Mr. Thompson, who died in January, 1906, from "bilateral pneumonia following influenza," and about whose medical history, *quâ* Mediterranean Fever, no evidence can be obtained, only one person—a woman at the quarantine station—took the milk in any quantity. She, however, drank the mixed milk from several goats for a considerable period, and in December, 1905, suffered from a typical attack of Mediterranean Fever.

3. *The Results.*

In summarising the result of this unpremeditated experiment, several factors have to be considered. For instance, a certain unknown number of goats—more, however, than two—were shown to be secreting infective milk after their arrival in America, some three months after leaving Malta, but there is no direct evidence as to the number whose milk contained *M. melitensis* during the voyage, in summer weather, from Malta to Antwerp. Arguing from analogy with average Maltese herds, at least six should have been secreting infective milk. The goats purchased by Mr. Thompson were, however, picked animals and heavy milkers, and as experience has shown that the goats yielding the most milk in any given herd are the most likely to be passing *M. melitensis* in their milk, the probability is that in this particular herd of 60 milch goats (one having died the day after leaving Malta) the milk from considerably more than six was heavily infected—an inference which receives confirmation from the fact that the three officers and the steward who drank "mixed" milk each developed an attack of Mediterranean Fever, the remaining officer and the cabin boy, with whom the milk disagreed and who consequently did not drink it, remained well.

The members of the crew, on the other hand, each drank "whole" milk from a single goat, and apart from the possibilities of the milk being supplied on any particular occasion from an uninfected animal, a reference to Section I (3), shows clearly the possibilities of a man who obtains milk, even from an infected animal, avoiding the ingestion of *infective* milk.

Apart from such considerations, however, it suffices to state the net result as follows:—

Of 23* men on board the s.s. "Joshua Nicholson" who drank on one or more occasions presumably infected milk, no evidence whatever is available as to 12 and no relevant information as to Mr. Thompson; of the remaining 10, one suffered from hernia only, one was infected by *M. melitensis* at an unknown date, while eight suffered from febrile attacks—5 (or 50 per cent. of them) yielding conclusive evidence of infection by *M. melitensis*.

IV.—The *Rôle* of the Mosquito and other Blood-sucking Insects in the Dissemination of *M. melitensis*.

That the mosquito may act as the vehicle in the conveyance of the infection of Mediterranean Fever may be an example of the wish being father to the thought, and due in part to the inconvenience caused to residents in Malta by these little pests. The rise in the case-incidence curve of the disease in June, July, August and September,† roughly corresponding as it does to the mosquito season, gives colour to a suggestion which is by no means new. In 1902 Zammit produced detailed evidence of an epidemiological character in support of the mosquito theory—that is to say before this observer had noted the natural infection of goats—later on Zammit, Horrocks and Kennedy produced experimental evidence of similar tendency, and more recently still Ross has laboured the point on purely theoretical grounds.

Before, however, attacking the question of the conveyance of *M. melitensis* infection, it became necessary to study the species of mosquitoes prevalent in Malta, since it seemed possible, arguing from analogy, that some one particular species, and one only, acted as the vehicle.

1. *Species of Mosquitoes occurring in Malta.*

Six species, representing five genera and two sub-families, are of common occurrence, viz.:—

Culex fatigans	Sub-family Culicina.
Culex pipiens	
Theobaldia spathipalpis......	
Acartomyia Zammitii	
Stegomyia fasciata	
Anopheles maculipennis......	Sub-family Anophelina.

and apart from Anopheles, which is restricted at present, so far as breeding place is concerned, to one valley in the centre of the island,

* That is disregarding the two men who boiled the milk before drinking it, and the officer and cabin boy who did not drink the milk.

† Johnstone, these Reports, II, p. 36.

Table XXI.—Synopsis of the Characters of the Maltese Mosquitoes.

	I and II. *Culex fatigans* and *C. pipiens.*	III. *Theobaldia spathipalpis.*	IV. *Acartomyia Zammitii.*	V. *Stegomyia fasciata.*	VI. *Anopheles maculipennis.*
Distribution	Over the entire island. Essentially a domestic mosquito.	As I and II.	Round the entire coast-line. On first appearance is found also in houses in urban districts.	As I and II.	Restricted to the Wied Ta Klighi, a deep valley between the Imtarfa and Klighi Hills.
Breeding places	Shallow stagnant pools; agricultural water-tanks; any small collections of stagnant water in artificial receptacles, such as flower-pots and saucers, buckets, old tins, etc., near to human habitations.	As I and II. Also in slowly flowing watercourses in rural districts.	In the salt pans on the rocky coast. In salt-water pools along the shores of the harbours.	As I and II. Often found in the same collection of water.	In the watercourse occupying the bed of the ravine from Fiddian Bridge to the artificial dam.
Time of appearance	Found all through the year.	As I and II.	April to October.	June or July to September.	May or June to September.
Most plentiful	From May to July onward to September.	May to August.	After October the heavy seas produced by the Grigali wind cause the disappearance of this mosquito.	July and August.	After September the watercourse is full and swiftly running.
Ovum— Length	0·7 to 0·9 mm.	1 mm.	0·5 mm.	0·4 to 0·6 mm.	0·7 mm.
Shape	Oblong, slightly curved; one end rounded, the other somewhat pointed.	As I and II.	Pointed oval.	Ovoid, more pointed at one end than other. Surrounded by a series of small air-chambers, which give a reticulated appearance to surface.	Elliptical.
Colour	White when first laid, rapidly turning grey, brown, and finally black.	As I and II.	White when first laid, rapidly becoming dark brown and black.	As I and II.	White, rapidly turning to greyish black.
How deposited	In masses or rafts irregularly quadrilateral, or elongated spindle-shaped; 5—8 mm. long × 3—4 mm. broad. Upper surface of raft slightly concave, as eggs, which cohere by sticky lateral surfaces, are arranged pointed ends upwards.	Rafts larger than I and II; pointed oval or boat-shaped, 10—15 mm. long by 5—8 mm. at broadest point.	Usually in rows, side by side, like a palisade, rarely singly or in pairs.	Singly and in pairs, side by side.	Singly, but float close to each other, and often cohere by their ends and form triangular patterns.
Number	200—400.	100—200.	25—100.	40—150.	40—100.
When deposited	Soon after sunrise, and also at dusk.	As I and II.	As I and II.	As I and II. Also at mid-day.	As I and II.
Period of incubation	24—72 hours. The larvæ escape through the thin rounded lower ends of ova.	As I and II.	As I and II.	48 hours to 3 days.	As I and II.
Larva— Size of adult	4 mm. long.	10 mm. to 12 or 14 mm.	5 mm. long.	6 mm. long.	5—7 mm. long.

Colour	Pale grey or straw-coloured with greenish tinge, or deep dirty brown.	Pale greenish to greenish brown.	Grey to light brown.	Greyish white.	Yellowish green to green or black, with mesial dorsal dark stripe.
Head	Large, with very prominent dark eyes.	Bright chestnut-brown, with black eyes, and band across nape.	Quadrangular, prominent oval eyes.	Large and quadrangular, smaller than thorax.	Small, oval in shape, with many black spots.
Thorax	Larger than head.	Wider than head.	Larger than head; three tufts of bristles on either side.	—	Broader than head.
Abdomen...	Nine segments, four anal fins at apex of ninth.	—	All nine segments nearly the same width. Segments 1 to 8 bear lateral tufts of long bristles. Segment 9 bears four anal papillæ at apex and ventral tufts of bristles arranged fanwise.	All nine segments nearly the same width. Anal fins short, bluntly finger-shaped.	Nine segments progressively decrease in width, but increase in length. Segments 1 to 3 bear long lateral bristles, which balance larva horizontal to surface film. Joint 9 bears swimming fan formed of long feathered bristles. Segment 9 carries four anal papillæ only.
Respiratory tube	Long, rising from eighth segment.	Short and thick.	Long, rising from 8th segment.	Short, broad, barrel shaped, and black in colour.	Two simple spiracles only on 8th segment.
Position when breathing	Hangs obliquely or vertically, head downwards, top of siphon at surface film.	As I and II.	Obliquely, head downwards or horizontally just below surface film.	At small angle to surface film, or horizontal. Remains at bottom of water for long periods.	Horizontal immediately below the surface film.
Duration of larval stage ...	Moults three or four times during a period of 14—21 days.	As I and II.	11—15 days.	8—12 days.	16—21 days.
PUPA—					
Size..................................	6 to 8 mm.	8 to 10 mm.	5—6 mm.	7 mm.	7 mm.
Colour	Dirty brown.	Dirty brown.	Dark brown.	Deep brown.	Yellowish green to grass-green, or dull brown.
Head and thorax	Fused.				
Eyes	Large, oval, prominent.	—	Oval and prominent.		
Respiratory horns	Two trumpet-shaped, narrow bases, oblique openings rise from dorsum of thorax.	Curved with truncated ends.	Curved, funicular, narrow bases, oblique openings.	Large, broadly cylindrical, obliquely truncated at apex, narrowed at base.	Short with square truncated ends.
Abdomen	Nine segments, flattened dorso-ventrally. 8th segment carries pair of oval fins, supported on hard mid-rib. 9th segment carries blunt process on either side of anus.	1st segment, tree-like tuft of bristles on dorsum. 9th segment, prominent anal fins.	As I and II.	1st segment, tuft of bristles. Two broad anal fins with long central rod.	Segments 4 to 8, black spot on either side.
Duration of pupal stage...	Imago emerges in from 2 to 4 days.	As I and II.	1—3 days.	2—3 days.	5—10 days.

Table XXI—*continued.*

	I and II. *Culex fatigans* and *C. pipiens.*	III. *Theobaldia spathipalpis.*	IV. *Acartomyia Zammitii.*	V. *Stegomyia fasciata.*	VI. *Anopheles maculipennis.*
IMAGO—Size	♀ 4·5 to 5·5 mm.; ♂ slightly smaller, 4—5 mm.	9—11 mm.	4—4·5 mm.	3—5 mm.	5—7 mm.
Head	Brown, covered with pale golden brown curved scales, with scattered dark brown upright forked scales.	Almost black, with two median curved lines uniting in front and behind as a white line between the eyes.	Ochraceous yellow at the sides. White in the middle.	Dark brown or black, with white patch in the middle and white patch on either side.	Black, with two patches of creamy scales, divided by a central line.
Thorax	Brown, with curved scales; two parallel dark lines and three rows of black bristles. Ornamentation very variable.	Umber brown with white lines and spots.	Brown with yellowish and creamy curved scales.	Dark reddish brown, with two median parallel pale lines and a curved silvery line on each side.	Brown, bluish gray in centre, deep brown at sides.
Abdomen, dorsum	Dark brown scales, with flaxen basal bands, broader laterally to form spots.	Yellow scales with scattered black scales.	Blackish brown with basal white bands.	Black, with white basal bands and lateral spots.	Dark brown, with tawny brown markings and dark apical bands.
,, venter	Pale yellow scaled.	Pale flaxen scales with few scattered dark ones.	All creamy.		
Legs	Dark brown and unbanded; bases of coxæ and femora pale; knee-spot white or yellow; tarsi dark brown; ungues, ♀ equal and simple, ♂ fore and mid unequal and toothed, hind equal and simple.	Coxæ yellowish with white scales. femora pale at base with ragged yellowish band before apex; tibiæ striped black and white; metatarsus black with white basal band; tarsi black; ungues equal and simple.	Brown apical and basal pale bands. The last hind tarsal white. Ungues equal and simple.	Black with basal white bands. Last segment of hind legs pure white. Fore and mid ungues toothed; hind untoothed.	Unbanded, brown. Small pale knee-spot, tarsi dark brown, ungues equal and simple.
Wings	1st sub-marginal cell longer and narrower than 2nd posterior cell. *C. fatigans*, ratio stem to cell = 1 : 4. *C. pipiens* ,, ,, = 1 : 7.	Curved, with long brown scales aggregated to form three distinct dark spots, one where the 2nd long vein rises from the 1st, one at the anterior and mid cross veins, and one at the fork of the 5th long vein.	Mottled brown and grey scales.	Veins clothed with long, narrow, brown scales.	Covered with narrow black scales aggregated to form four spots, one at the base of the first fork cell, one at the second fork cell, one at the cross veins, and one at the base of the second long vein.

[I am much indebted to Mr. F. V. Theobald, F.E.S., for his kindness in reading through the proof of this table, and supplying data for some of the then blank spaces.—JNO. EYRE.]

and Acartomyia, which breeds along the coast line, these species are fairly uniformly distributed over the entire island.

The accompanying synoptical table, adapted from Theobald in accordance with observations made in Malta during the summer of 1906, details the chief points of similarity and distinction between the various mosquitoes, and is introduced here in the hope that it may prove helpful to workers in Malta in this or similar fields.

2. *Supply of Mosquitoes and Notes on their Habits in Captivity.*

The supply of insects required for the experimental work in connection with the attempts to transmit *M. melitensis* infection by the aid of mosquitoes was kept up by repeatedly collecting large quantities of larvæ and pupæ, transferring them to shallow glass dishes of water and allowing them there to complete their development—each species being confined in a separate gauze covered breeding-cage provided with two soft gauze sleeves (of sufficient capacity to admit the hand and arm), situated in the front of the cage and so permitting ready access to any part of the interior. To facilitate the entry of the hand, the free extremity of the long sleeve was attached to a circle of

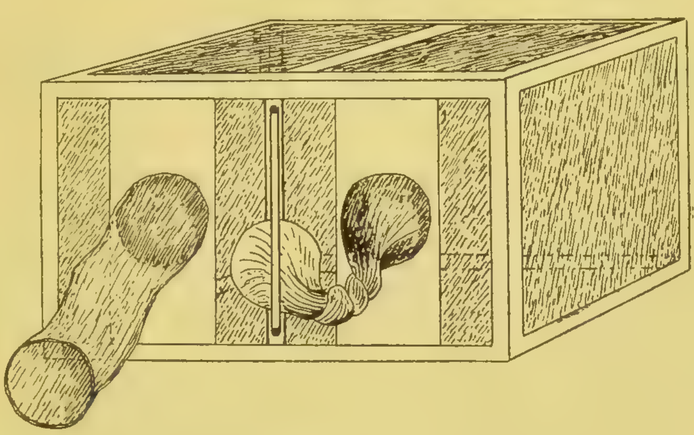


Fig. 3.—Mosquito Breeding Cage.

wire. By twisting the sleeve upon itself and pushing the wire circle under a tightly stretched piece of elastic (attached to the front of the cage) the imagines were effectually prevented from escaping (fig. 3). With adequate care, in such a cage the mortality of imagines when they emerged from their pupa cases was by no means excessive, and after being fed on blood the impregnated females readily laid their eggs in the water in which they had passed the early stages of their existence.

The morning of the day preceding a feeding experiment the perfect females were captured in detail and each transferred to a short length of glass tubing (4 to 6 cm. long by 1·5 cm. in diameter) covered at

one end with a piece of muslin secured by an indiarubber band and closed at the other by a well-fitting cork, where they remained, without food, for from 30 to 32 hours. This useful little piece of apparatus (fig. 4) enabled a distinguishing number or letter to be assigned to every mosquito, simplified the handling of the insects, and rendered it an easy matter to ascertain that feeding had actually taken place, and indeed to watch the entire progress of the act.

Fig. 4.—Experimental Feeding-tube for Mosquitoes.

In connection with these experiments many difficulties, varying with the species, were encountered, some of which may be usefully referred to.

In the first place, cannibalism is a marked feature of mosquito life during the larval stage, of all the species, and probably not more than 50 per cent. of the larvæ—under laboratory conditions—attain maturity. The occasional addition of a few grains of tapioca to the water containing the larvæ certainly reduces, but by no means prevents, this wastage.

Then it was soon found that female Acartomyia and sometimes *Culex* (*fatigans* and *pipiens*) when segregrated immediately after emerging from the pupa were weakly, could not under any conditions be induced to bite, and soon died. This reluctance of the virgin to suck blood has frequently been noted, and it was consequently found necessary to allow the females to remain in company with the males for two or three days after emerging from the pupa in order to ensure an adequate supply of impregnated females, the insects being freely supplied with fruit—chiefly apples—and syrup during this period. By adopting this method the weakly imagines, which quickly died, were weeded out and a supply of sturdy females was insured.

Again, Acartomyia, although naturally a voracious feeder during the daytime as well as after dusk, like Culex could not in captivity be induced to bite until after dusk and occasionally until after night was

well advanced. Captive Stegomyia, on the other hand, bit readily at any time during the 24 hours.

In feeding mosquitoes a large fund of patience is required. Some, particularly Stegomyia, will go down as soon as applied to the skin and commence feeding at once; others, like Acartomyia, are a considerable time testing area after area of skin with the proboscis before a suitable spot is found and the actual abstraction of blood begins. Individuals again may have to be coaxed before they will begin operations by shading the tube in which they are confined from the direct light, or by raising its internal temperature by closely encircling it with the hand.

Having commenced to feed, the time taken by various individuals to completely fill themselves varies largely and bears no direct relationship to the size of the insect. A presumably thirsty Stegomyia will sometimes fill itself inside 30 seconds, another of apparently equal capacity, or the same individual on another occasion will require some 15 minutes to reach the stage of repletion: Acartomyia usually requires from one minute to five minutes to complete the meal. The shortest time noted was achieved by one of the largest Stegomyia in our possession, which required only 15 seconds to appease its appetite.

The quantity of blood taken up by the insect at one feed is also a matter of some importance, for the minimal quantity of blood from Malta Fever patients in which Gilmour and Shaw* were able to demonstrate the presence of *M. melitensis* was approximately 3 and 4 cubic millimetres respectively. The micrococcus may, however, be present in the blood of human patients in much greater numbers than these figures would seem to indicate (*vide* p. 125), as shown by the examination of the blood in a small series of cases this summer, when *M. melitensis* was once found to the number of 10,000 per cubic centimetre—a quantity of infective material in the blood stream comparing with that found in mild cases of malaria or very severe cases of streptococcic septicæmia.

Estimations were therefore made by weighing one of the empty mosquito tubes, transferring a captured mosquito to its interior and again weighing it—the difference being taken to represent the weight of the insect. The mosquito was immediately fed and again weighed, the difference in the weights of tube *plus* mosquito, before and after feeding, being regarded as the weight of the blood ingested, and may fairly be taken as sufficiently accurate for practical purposes. From a series of eight such weighings the average quantity of blood taken up by Stegomyia was 3 milligrammes, the extremes noted being 1·5 milligrammes and 5·5 milligrammes. *Stegomyia fasciata* was the species selected for the purpose of this experiment, on account of the

* *Vide* these Reports, I, p. 10, and III, p. 19.

readiness with which this insect bites even during the day time. Thus all the operations of weighing, feeding, and again weighing could be carried out out during the middle of the day, when the air temperature was at its maximum, and the air humidity, which is an important factor in Malta, where delicate weighings are involved, at its lowest point. The details of these weighings are given in tabular form below.

The amount of blood taken by a mosquito bears relationship to the elasticity of the skin of the abdomen rather than to the size of the insect, for of the two extremes noted the maximum, 0·0055 gramme blood, was ingested by a very small female—much smaller, in fact, than its weight (empty) would indicate.

Table XXII.—Showing Average Weight of *Stegomyia fasciata* before Feeding, and of Blood Ingested when the Insect was filled to Repletion.

No.	Weight of fasting mosquito.	Weight of mosquito *plus* blood—after feeding.	Weight of blood ingested at one meal (deduced from difference in weights given in Cols. II and IV).
	gramme.	gramme.	gramme.
1	0·0020	0·0035	0·0015
2	0·0020	0·0055	0·0035
3	0·0020	0·0065	0·0045
4	0·0030	0·0072	0·0042
5	0·0030	0·0085	0·0055
6	0·0080	0·0105	0·0025
7	0·0020	0·0045	0·0025
8	0·0010	0·0035	0·0025
Average	0·00262	0·00621	0·00333

3. *The Duration of Life of* M. melitensis *in the Body of the Mosquito.*

Since the species of mosquito common to the Island as a rule only feed upon the human subject at intervals of 48 hours, the first and most important points for consideration were (1) whether the mosquito would serve as a host for the micro-organism, and if so (2) the duration of life of the *M. melitensis* in the insect's body.

Previous workers* had isolated *M. melitentis* from the bodies of four mosquitoes (captured in the wards of hospitals where they had had opportunities of biting patients suffering from Malta Fever as well as patients suffering from other diseases, and also normal individuals),

* Horrocks and Kennedy, *vide* these Reports, IV, p. 72.

out of a total of 450 which they had dissected, and therefore disregarding the possibility of accidental external contamination of the mosquitoes, it was assumed to be proved that the mosquito could act as a host for *M. melitensis*, thus disposing of the first point.

With regard to the second point, the simplest method of determining the duration of life of the micro-organism within the insect's body would have been to feed a large number of mosquitoes simultaneously upon a patient suffering from Mediterranean Fever in whose blood *M. melitensis* was known to exist in large numbers; then to dissect several mosquitoes at regular intervals and prepare plate cultivations from the contents of the stomach, etc. The difficulties in carrying out such an experiment were great. Cases of Mediterranean Fever in the wards of the Military and Naval Hospitals were few in number and mild in character; moreover, Gilmour and Shaw had stated that the micrococcus could only be isolated from comparatively large quantities of blood, and that its presence was by no means constant. On humanitarian grounds, too, it did not appear justifiable to subject any one patient to the discomfort of being thus bitten by scores of mosquitoes in the prosecution of what were, after all, but preliminary observations.

Advantage was, therefore, taken of the fact that an extremely acute septicæmia, associated with the presence of numerous cocci in the peripheral circulation, can readily be induced in the guinea-pig by means of intracerebral inoculation of highly virulent cultivations of *M. melitensis*,* consequently this animal was substituted for the human subject and, with this modification, the experiments suggested above were initiated.

The procedure adopted was as follows :—

At 8 or 9 A.M., two or three guinea-pigs were successively anæsthetised and injected intracranially with 0·1 of a loop of a 24-hour-old culture of the highly virulent culture emulsified in 0·05 c.c. Advantage was taken of the insensibility of the animal to epilate a fair-sized area of the skin of the back between the shoulders. The temperature of the animal was then carefully watched. Usually, five or six hours later, or by 5 P.M. at latest, the temperature had reached 105° or 106° F., and was maintained at this level for many hours; with such a temperature it was known, as a matter of experience, that the circulating blood contained numerous cocci. The mosquito tubes already described, each containing an impregnated female mosquito, were then applied in turn, gauze covered end downwards, to the guinea-pig's back over the area of skin previously denuded of hair, and the insects allowed to fill themselves with blood. Immediately the entire batch of insects had fed, several insects were killed by ether vapour, placed in sterile Petri dishes and dissected at once. The bloody contents of

* Eyre, *vide* these Reports, II, p. 75.

the stomach were removed and emulsified with a small quantity of sterile salt citrate solution (0·75-per-cent. sodium chloride and 1-per-cent. sodium citrate in distilled water) and distributed over the surface of three or more nutrose-agar plates. After incubation, the colonies of *M. melitensis* that had developed were enumerated and their identity verified. This process was repeated at regular intervals, two or three insects being destroyed every 24 hours or so, and the contents of their stomachs plated, the unused insects being kept in a cage containing a vessel of water in which to lay their eggs, and supplied with fresh fruit, or retained in the separate feeding-tubes into which small cubes of apple or other fruit were introduce ddaily. In this way it was determined that the numbers of *M. melitensis* usually decreased as time went on, the greater number being voided with the droppings in the first 48 hours after feeding, but that in one or two instances the cocci appeared to actually multiply in the mosquito's stomach for a day or two, while it was certainly proved that living micrococci could be demonstrated in the interior of the mosquito four days after feeding on an infected animal.

4. *Experiments with* Acartomyia Zammitii.

The distribution of *Acartomyia Zammitii*, restricted as it appears to be to the Mediterranean littoral, and so corresponding to the chief incidence of Malta Fever, is held by some to give to this unique mosquito an especial claim to the carriage of the specific micro-organism of the Fever; and as moreover it is the first mosquito to appear in early summer in any considerable numbers, attention was first directed to it.

This insect, which has only comparatively recently been recognised as a distinct entity (being formerly regarded as a common Culex), is peculiar in that the early stages of its existence, from ovum to pupa, are passed in salt water. All around the coast line of the Island are rock pools above high-water mark filled with salt water, but not in direct communication with the sea, legacies of the stormy Grigali, a north-east wind which prevails from October to April. These pools remain isolated throughout the summer, and the contained salt water becomes highly concentrated from the evaporation that takes place during the hot weather.

The Acartomyia season begins in April or May, and is abruptly terminated by the first Grigali of winter. The larvæ of Acartomyia are to be found in practically all these rock pools, but are especially numerous in the half natural, half artificial salt pans in the neighbourhood of the northern and eastern coasts of the Island. It is interesting to note that a certain amount of discrimination is exercised by the female in the selection of water in which to lay her eggs. Sea water from the Mediterranean contains a larger percentage of salt

(2·72 per cent. sodium chloride) than open seas, and the average content of the more concentrated pools in which larvæ and pupæ are most abundant reaches a still higher figure (7·68 per cent.). Many attempts were made to induce the captive female to lay her eggs in fresh water or in ordinary sea water, but without success. Immediately, however, salt water of the necessary density was placed in the cage the eggs were deposited therein, even when the water was in a large glass vessel and had neither seaweed, *débris*, or empty pupa cases upon which the insect could rest during the process, and so was drowned at its termination. Again, if three vessels of water were placed simultaneously in a breeding cage containing females ready to lay their eggs, the first filled with fresh water, the second with ordinary sea water, and the third with concentrated salt water, all the eggs would be found deposited in the concentrated salt water within 24 hours, and none would be present in either of the other two vessels. The eggs are pointed ovals, averaging 0·5 mm. in length, white when first laid, but rapidly becoming brown and then black. They are laid singly or in pairs, or most commonly in rows resembling palisades, the individual eggs being arranged side by side. Under the ordinary conditions of nature, that is free exposure to air and sunlight, the eggs hatch out in from 24 to 72 hours. If transferred to fresh water immediately after being laid, the eggs do not hatch. Freshly hatched larvæ die if transferred from concentrated salt water to perfectly fresh water, but in the case of adult larvæ taken from their natural habitat and placed in tap water, development proceeds in a normal manner, but the remainder of the larval stage and the pupal stage are much prolonged. Some interesting observations on the habits of this mosquito have been recorded by Ross in a communication to the Liverpool School of Tropical Medicine.*

(a) *Duration of Life of* M. melitensis *in* Acartomyia Zammitii.

Working on the lines already indicated, several series of Acartomyia were fed on infected animals, then two or more destroyed after each of several intervals of time, the contents of the stomach of each plated out, and an enumeration made of the number of *M. melitensis* developing and the total contents of all stomachs averaged. In the later series the salivary glands were dissected carefully out and plated separately, but in no case was *M. melitensis* isolated from this situation. During the intervals between the platings the infected mosquitoes were kept alive by supplying them daily with fresh fruit, etc., or by regularly feeding them on alternate days on healthy monkeys in the attempt to transmit infection.

* Ross, E. H., " On the Habits of the Marine Mosquito (*Acartomyia Zammitii*)," Reports of the Liverpool School of Tropical Medicine, Memoir XVIII, 1906.

Table XXIII.—*Acartomyia Zammitii* as the Host of *M. melitensis*.

No. of series.	Source of infection.	Interval between feeding and dissecting.	Number of mosquitoes dissected and plated.	Average number of *M. melitensis* per stomach.	Average number of *M. melitensis* per pair of salivary glands.
I	Guinea-pig No. 6.........	12 hours	2	116	not examined
		48 "	3	3	" "
		72 "	2	nil	" "
		96 "	2	nil	" "
II	Guinea-pig No. 80	15 minutes	2	60	not examined
		24 hours	3	17	" "
		48 "	3	386	nil
		72 "	3	6000	nil
		96 "	2	813	nil
		144 "	2	nil	nil
III	Guinea-pig No. 112......	15 minutes	3	236	not examined
		48 hours	3	nil	nil
		96 "	2	nil	nil
IV	Guinea-pig No. 113......	15 minutes	2	673	not examined
		36 hours	3	2386	nil
		48 "	2	9243	nil
		84 "	2	nil	nil
		96 "	2	nil	nil

From these preliminary investigations it will be seen that in two of the series where the original meal of blood from the infected guinea-pig contained a fairly large number of cocci, the blood present in the stomach of the host proved a suitable nidus for the ingested micrococci and that multiplication proceeded for a limited period, but by the fourth or fifth day at latest the micrococcus had disappeared from the stomach of its host, whilst examination of the salivary glands invariably failed to demonstrate its presence. It is interesting to note, and is probably explanatory of the observation, that these two series comprised insects that had been fed upon healthy monkeys in the interval between 48 and 72 hours.

By establishing plate cultivations from the black and brownish droppings of the infected mosquitoes collected from the sides and corks of the mosquito tubes, the fate of the *M. melitensis* was explained, for the excrement was found to contain the micrococcus in large numbers for the few days following the feeding, and as long as any altered blood was being voided; as soon as the excrement regained its yellowish or white colour, the *M. melitensis* ceased to be demonstrable in it. The living coccus could also be recovered from excrement voided certainly 10 days previously. The full details of four of these series of investigations are here inserted (see Table XXIII).

(b) *Virulence of* M. melitensis *after Passage through* Acartomyia Zammitii.

Having thus determined approximately the duration of the stay of *M. melitensis* in the body of the mosquito and the path by which it leaves the insect, experiments were made to determine whether the coccus undergoes any vital change as a consequence of its sojourn in an insect host. In the first place cultivations of cocci, isolated from the mosquito stomach and from the droppings respectively, were employed to inoculate healthy guinea-pigs intracerebrally.

As in each case positive results were obtained, and the animals succumbed from an acute *M. melitensis* septicæmia, further experiments were carried out in which the infected blood contained in the stomachs of individual mosquitoes was inserted under the dura mater of the guinea-pig. These experiments also gave uniformly positive results, and the inevitable conclusion is that the coccus undergoes no loss of virulence in its passage through the body of the mosquito. Details of some of these experiments are inserted in Table XXIV (p. 86).

(c) Acartomyia Zammitii *as the Infective Agent.*

Attention was now directed to the question of the transference of *M. melitensis* to the monkey *viâ* Acartomyia, and for this purpose healthy monkeys in good condition which had been under observation, housed

Table XXIV.—Virulence of *M. melitensis* after Passage through Mosquito.

Guinea-pig No.	Dose of *M. melitensis*.	Source of *M. melitensis*.	Method of inoculation.	Result.
I	loop. 0·1	Culture from fæces of mosquito in Series I, Table XXIII	Intracranial	Death in 30 hrs. from *M. melitensis* septicæmia.
II	0·1	Culture from fæces of mosquito in Series I, Table XXIII	,,	Death in 30 hrs. from *M. melitensis* septicæmia.
III	0·1	Culture from stomach of mosquito 48 hours after feeding (Series II, Table XXIII)	,,	Death in 48 hrs. from *M. melitensis* septicæmia.
IV	Contents—blood and cocci—of stomach of Acartomyia 48 hours after feeding (*cf.* Series II, Table XXIII), mixed with 0·1 c.c. normal saline solution		Subdural	Death in less than 24 hrs. from *M. melitensis* septicæmia.

in mosquito-proof cubicles for a considerable period, and which had never shown any evidence of the presence of specific agglutinins in their blood were selected, and transferred to separate mosquito-proof cubicles on the Laboratory terrace. On the morning of the day on which it was to be subjected to the bites of the infected mosquito, the back of the thighs and legs of the experimental monkey were closely shaved, care being taken to avoid abrading the skin. The animal was then returned to its cage until the commencement of the experiment. When all was ready the animal was brought into the laboratory and stretched out face downwards on a table. The shaved areas of skin having been washed with distilled water and dried, the mosquitoes, each in its separate tube, were applied to the denuded spot and allowed to feed. This was often a tedious process and required some hours for its completion, and when using Acartomyia the feeding was often prolonged until after midnight; still, given adequate assistance in securing the monkey, as many as four of the mosquito-tubes could be manipulated by one worker.

In these experiments the process of feeding was carefully watched—to beguile the tedium of waiting as much as to ascertain the moment of repletion—and is here briefly described on account of the important bearing one feature of the process has upon the question of the infection of man through the agency of this insect. The mosquito having decided to feed, settles down at the gauze covered end of the tube, and after a few preliminary investigations with its proboscis, determines on

the point of skin to be punctured. Next the head and proboscis are lowered, while the body remains more or less horizontal. Then the hind pair of legs are raised to the level of the posterior part of the abdomen, and employed in massaging the abdomen by a series of stroking movements passing from the thorax towards the anus. These movements often, but not invariably, result in the extrusion of some of the intestinal contents which, in the case of insects previously fed on mammals, is easily recognisable by reason of its colour. This small mass of excrement drops either on to the gauze covering the tubes, or where the meshes are wide, actually on to the skin of the animal upon which the mosquito is feeding. In the meantime the abdomen of the insect has become distended with blood, and as soon as the mosquito has completed its meal the proboscis is withdrawn, stroked and cleaned by the help of the anterior pair of legs, and then the insect flies up to the upper part of the tube and settles down in a resting position. This sequence of events holds good in the case of other blood-sucking species of mosquito as well as Acartomyia.

Leaving now, for a moment, the region of observed facts for a short incursion into the realms of theory, it appears highly probable that a mosquito having fed on a case of Malta Fever in the acute septicæmic stage whose blood contained large numbers of the cocci, might, 48 hours later, settle upon a healthy individual and proceed to insert its proboscis into the skin. Massaging its abdomen, the mosquito then deposits a mass of bloody excrement, enclosing the coccus in a virulent condition, upon the surface of the skin, a few millimetres distant from the puncture made by its proboscis. The bitten individual, now alive to the fact that a mosquito is feeding upon him, rouses himself, frightens off the mosquito or kills it *in situ*, and promptly proceeds to thoroughly scratch the infective excrement into the site of the minute wound and, following a successful inoculation, an attack of Malta Fever ensues. Such a sequence of events is well within the range of possibility, and yet the necessary combination of factors is sufficiently uncommon to render this method of infection as rare as the experiments upon monkeys would indicate.

To return to the actual experiments—after feeding a number of infected mosquitoes upon the monkey, the animal was returned to its cubicle and carefully observed from day to day until some four to six weeks had elapsed, when the animal was killed and carefully examined *post-mortem.*

Of the experiments carried out with the aid of *Acartomyia Zammitii*, but one monkey was infected, and in this case the infection was an extremely mild one. The history of this experiment is as follows :—

Normal Monkey No. 175 was bitten, late at night, by six Acartomyia, which had fed between 48 and 50 hours before on Guinea-pig No. 71 (which succumbed to *M. melitensis* septicæmia 10 hours after

intracerebral inoculation, and the heart blood at the *post-mortem* examination was found to be absolutely teeming with the micrococci). The stomach contents of some of the mosquitoes, plated immediately after the termination of the feeding, yielded plates in which the colonies of *M. melitensis* were so numerous as to be absolutely uncountable. The bitten monkey was subsequently kept in a mosquito-proof cubicle, and every precaution which experience could suggest was taken to avoid any chance of accidental infection. The serum was tested on alternate days for the presence of *M. melitensis* agglutinins, and on the 11th day gave a positive reaction in dilution of 1 in 20. The serum value rose gradually, and on the 15th day had reacted 1 in 80, while an incomplete reaction was given with a dilution of 1 in 100. On the 21st day no reaction could be obtained, even with 1 in 10 dilutions, therefore the animal was killed. During the period of three weeks, in which the monkey was under observation, the temperature chart, which is here inserted, gave no indication whatever of a successful subcutaneous inoculation.

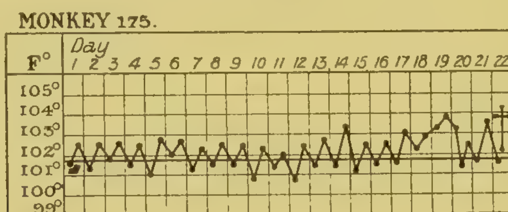


Chart 10.

At the *post-mortem* examination the spleen was found to be slightly enlarged, and all the superficial glands were markedly enlarged and congested.

In none of the plate cultivations prepared from heart blood, spleen pulp, and axillary and inguinal glands could *M. melitensis* be detected, but in one of the three tube cultures prepared from spleen pulp two colonies appeared of a minute coccus, which when tested against specific serum became agglutinated, although in a somewhat atypical manner. Subcultivations were prepared from these, and further investigation proved that one of the two colonies was composed of genuine *M. melitensis.*

In none of the other monkeys did the serum at any time during the period of observation contain specific agglutinins, nor could the presence of *M. melitensis* be detected in the blood. Finally, at the *post-mortem* examination *M. melitensis* was never recovered from any of the other organs or tissues.

Before tabulating the results of those of the Acartomyia experiments in which the value of each factor was accurately known, it may be useful to recapitulate the exact method of procedure—a reiteration which the importance of the subject alone condones :—

(*a*) First a healthy guinea-pig was inoculated intracerebrally with a sufficient dose of highly-virulent culture of *M. melitensis* to produce such an acute infection that in the course of a few hours large numbers of the cocci would be present in the peripheral blood.

(*b*) Next, when the temperature of the inoculated guinea-pig had reached 105° F. or 106° F. (a point which previous experience had shown corresponded to rapid multiplication of cocci in the blood), the first feeding of the mosquitoes was commenced.

(*c*) Several female mosquitoes—the number varying with the experiment from 20 to 70—each enclosed in a separate feeding tube, were applied one by one to a bare patch of skin between the infected guinea-pig's shoulders and encouraged to bite. As soon as one mosquito was seen to be full of blood, and to have settled to repose in another part of the tube, the tube was taken away, marked with its serial number, the number of the guinea-pig, and the date and time of feeding, and replaced by the next tube containing a fasting mosquito.

(*d*) During the progress of the feeding experiment, or immediately after its termination, some of the mosquitoes (the number varying in each experiment with the number of mosquitoes that had fed and were available) were killed with ether vapour, and the contents of the stomach plated out to determine the average number of cocci ingested with the blood of the guinea-pig. The feeding tubes containing the remainder of what may now, for purpose of reference, be termed "infected mosquitoes" were placed in test-tube racks and put on one side.

(*e*) Forty-eight hours after the primary feeding of the mosquito a healthy monkey was selected, stretched face downwards on a table, and the back of the fleshy part of each thigh and leg shaved, great care being taken to avoid cutting or grazing (this process was often carried out some hours earlier in the day). The shaved areas were washed with distilled water and partly dried with sterile wool.

(*f*) Each of the infected mosquitoes was now applied in turn to the shaved area, and allowed to bite the monkey and fill itself with blood. Some of course refused; these were put aside for feeding at 72 hours.

(*g*) At the termination of the feeding on the monkey two or three of the infected mosquitoes that had filled themselves were plated out to determine whether the contents of their stomachs still contained the *M. melitensis*, and to prove beyond question that the mosquitoes that bit the experimental animal actually contained infective material at the moment they were engaged in feeding on the monkey.

(*h*) At 72 hours after the primary feeding such infected mosquitoes as had refused to bite the first monkey (at 48 hours) and were still living, were applied to a second healthy monkey, and if they bit and filled themselves with blood the same routine was repeated.

Table XXV.—Transmission of *M. melitensis viâ* Acartomyia.

Infective agents.					Experimental animals.			
Source of infection.	Average number of *M. melitensis* per control mosquitoes.		Interval between primary feeding and biting monkey.	Number of mosquitoes employed in experiment.	No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
	Immediately after feeding.	At time of biting monkey.						
			hours.					
Guinea-pig No. 90...	2426	2070	48	12	Monkey No. 177	—	34	nil
Guinea-pig No. 112...	236	nil }	48	{ 8 }	Monkey No. 186	—	28	nil
Guinea-pig No. 113...	673	9243 }		{ 8 }				
Guinea-pig No. 71...	∞	∞	48	5	Monkey No. 175	11th day	21	1 colony of *M. melitensis* in one of the many cultures from spleen: other organs nil
Guinea-pig No. 72...	∞	∞	75	1	Monkey No. 176	—	43	nil
Guinea-pig No. 90...	2426	103	96	7	Monkey No. 178	—	32	nil
Guinea-pig No. 112...	236	nil }	96	9	Monkey No. 187	—	26	nil
Guinea-pig No. 113...	673	nil }						
Guinea-pig No. 90...	2426	nil	144	2	Monkey No. 179	—	24	nil

∞ = innumerable.

(*i*) At 96 hours after the primary feeding the infected mosquitoes (diminished in number as a result of death from natural causes or destruction for plating purposes) were applied to a third, and so on as long as any of the mosquitoes remained alive.

(*j*) The monkeys after being bitten were placed in mosquito-proof cubicles, and observed from day to day as to temperature and general condition, blood reactions, etc., until the termination of the experiment, when a careful *post-mortem* examination was carried out.

It was usual not possible to carry the above scheme beyond the 96 hours, owing to the death of the infected mosquitoes, as will be seen in Table XXV.

5. *Experiments with* Stegomyia fasciata.

Having dealt at some length with those mosquito experiments in which *Acartomyia Zammitii* was the species employed, those in which *Stegomyia fasciata* was employed as the infective agent may be briefly dismissed, for the technique was identical in both series of experiments.

(a) *Duration of Life of* M. melitensis *in* Stegomyia fasciata.—Experiments were made to determine the duration of life of *M. melitensis* in the stomach and intestines of Stegomyia in the manner already described (*vide* pp. 81 and 82), and the results obtained were very similar, for it was found that the micrococcus could rarely be recovered from this mosquito beyond four days after the primary feeding on the infected guinea-pig. The results of a few representative experiments are given below in Table XXVI :—

Table XXVI.—*Stegomyia fasciata* as the Host of *M. melitensis.*

No. of series.	Source of infection.	Interval between feeding and dissection.	Number of mosquitoes dissected and plated.	Average number of *M. melitensis* per stomach.
I	Guinea-pig No. 140	24 hours	2	∞
		48 ,,	2	6177
		72 ,,	3	*
		84 ,,	2	nil
II	Guinea-pig No. 150	30 minutes	3	∞
		48 hours	3	44
		96 ,,	2	nil
III	Guinea-pig No. 151	2 hours	1	∞
		24 ,,	2	44
		48 ,,	2	5
		72 ,,	2	*
		96 ,,	3	nil

∞ = innumerable.

* *M. melitensis* present, but plate unworkable owing to contamination with saprophytes probably derived from exterior surface of mosquito's abdomen.

(b) Stegomyia fasciata *as the Infective Agent.*—The experiments in which the attempt was made to transmit *M. melitensis* from the infected guinea-pig to the healthy monkey *viâ Stegomyia fasciata*, were planned and carried out in a manner identical with those detailed in connection with *Acartomyia Zammitii* (*vide* p. 86), consequently the technique need not again be described. The only point to be noted is that, as the solitary infection produced when Acartomyia was employed as the infective agent ensued when the mosquitoes bit a healthy monkey 48 hours after the primary feeding on the infected guinea-pig, the majority of the Stegomyia experiments were performed at that interval.

The possibility that infection might be produced as the result of puncturing the skin of the healthy subject by the soiled proboscis of a mosquito that had partly filled itself from an infected patient, was tested experimentally in one instance only, but in that single instance—as events subsequently proved—the conditions were exceptionally favourable to the transmission of the specific virus. The details of this experiment were as follows:—

One female Stegomyia, in its feeding tube, was applied to the back of an infected guinea-pig (prepared for the experiment by intracranial inoculation of *M. melitensis* 8½ hours previously) and allowed to settle down, insert its proboscis into the skin, and commence to feed. The instant that blood could be distinguished entering its abdomen, the feeding tube was removed and applied to the shaven leg—immediately over the external saphenous vein of Monkey No. 236, and the mosquito allowed to bite and complete its meal. Within half an hour of its removal from the monkey, the contents of this mosquito's stomach were plated out, but none of the plates that were prepared showed a single colony of *M. melitensis.*

Immediately the first mosquito had completed its meal, a second Stegomyia was applied to the guinea-pig and allowed to bite and about half fill its abdomen with blood. It was then transferred to the same monkey and applied, again over the external saphenous vein, at a point a centimetre or so above the first puncture. The mosquito settled down at once, inserted its proboscis, and proceeded to fill itself up with the monkey's blood. A short time after the mosquito had completed its meal, it was killed and the contents of its stomach plated out. Subsequent enumeration of the colonies of *M. melitensis* that developed on the plates showed that the stomach of this mosquito contained about 5000 cocci.

Following the feeding of the second mosquito, a third Stegomyia was half fed on the same infected guinea-pig and then transferred to the monkey and allowed to bite over the vein, just between the first and second mosquito bites, and complete its meal. All the plate cultivations prepared from the stomach contents of this third mosquito

Table XXVII.—Transmission of *M. melitensis viâ* Stegomyia.

Infective agents.					Experimental animals.			
Source of infection.	Average number of *M. melitensis* per mosquito.		Interval between primary feeding and biting monkey.	Number of mosquitoes employed in experiment.	No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
	Immediately after feeding.	At time of biting monkey.						
Guinea-pig No. 140	∞	6,177	48	5	Monkey No. 207	—	44	nil
Guinea-pig No. 181	?	350	48	5	Monkey No. 228	—	37	nil
Guinea-pig No. 151	∞	44	48	18	Monkey No. 230	—	40	nil
Guinea-pig No. 150	∞	10,000	48	12	Monkey No. 232	—	69	nil
Guinea-pig No. 150	∞	nil	96	8	Monkey No. 231	—	38	nil
Guinea-pig No. 140	∞	4,855*	15 secs.	3*	Monkey No. 236	—	46	nil
Guinea-pig No. 170	22	320	48	1	Monkey No. 238	—	37	nil

∞ = innumerable.

* All three mosquitoes were killed and examined; *M. melitensis* was absent from the stomach of the first, present to the number of 4855 in the second, and in innumerable numbers in the third.

yielded pure growth of *M. melitensis*, in which the colonies were so numerous as to be absolutely uncountable.

The monkey that had been bitten by these three mosquitoes, however, remained perfectly healthy, specific agglutinins remained absent from its blood, and, when killed and examined *post mortem* 46 days later, showed no signs of infection with *M. melitensis*.

Two of the three mosquitoes, therefore, that first sucked blood from an infected guinea-pig and then finished their meal upon blood abstracted from a healthy monkey were conclusively shown to have taken up with the guinea-pig's blood a very large number of the micrococcus and, one would infer, had had ample opportunity of soiling the proboscis in each case, yet the monkey remained uninfected.

Details of the experiments in which the various data were accurately ascertained are tabulated below; other similar experiments were performed, but, owing to failure of plate cultures and other causes, there was no evidence as to the numbers, or, indeed, the presence of *M. melitensis*, in the interior of the mosquitoes used for biting. Such experiments being worthless, are not included in the results presented in Table XXVII.

The net result of the mosquito experiments may now be summarised very briefly. Out of 14 experimental monkeys bitten under conditions which have been accurately recorded (and disregarding a further six, where the necessary data are missing in whole or in part, but in none of which did infection occur), one monkey alone has given evidence of actual infection. In this one positive case, the *M. melitensis* contained in the stomach of the mosquito at the time it bit the monkey—48 hours after the primary feeding on the infected guinea-pig—were innumerable in quantity, and the inference is justifiable that, if excrement was dropped on the skin while feeding on the monkey, numerous living and virulent *M. melitensis* must have been present therein. Consequently, after removal from the operating table there was nothing to prevent this monkey (or, indeed, any of the experimental monkeys) scratching the infective material into the puncture, and this is quite possibly a case in which some such variety of infection occurred.

6. *Experiments with other Species of Mosquitoes.*

(a) *Theobaldia spathipalpis.*—The opinion has been freely expressed in some quarters that the members of this species are fruit feeders only, and never suck blood. This statement, however, does not hold good for Malta, as, during the summers of 1905 and 1906, whilst examining specimens of mosquitoes captured in various parts of the Island, *Theobaldia* was sometimes noted gorged with blood. One of the members of the Commission received several specimens in the course of the winter of 1905—1906, which had been "caught feeding" on the human subject, one of which had so recently fed that the blood

cells were unaltered and could readily be demonstrated microscopically. This particular specimen was submitted to Mr. E. E. Austen for confirmation of identity, and his reply is here inserted :—

Copy of letter from Mr. E. E. Austen.

British Museum (Nat. Hist.),
Cromwell Road,
London, S.W.,
10*th January*, 1906.

Dear Sir,

I am very sorry that your letter of December 9th, enclosing a specimen of *Theobaldia* (*Culex*) *spathipalpis*, has remained so long unacknowledged. The letter arrived here while I was absent on a month's vacation, and since I have only just returned to duty, it was consequently impossible for me to reply sooner. Please forgive the delay.

Your identification of the species is perfectly correct, and the notes in your letter on its occurrence and blood-sucking habits in Malta are very interesting. I see you say that "it is described by Giles and Theobald as non-blood-sucking," but if you look at Theobald's monograph, vol. i, p. 341, you will see that the species is stated (apparently on the authority of Major Birt) to be "troublesome" in Gibraltar; it would appear, however, from the following page that Ficalni believes the species to be a vegetable feeder, and Grabham, writing with reference to Madeira in Theobald's monograph, vol. iii, p. 155, says "the people told me they had never observed this form attacking man or animals. They fed eagerly on banana slices, but never attempted to bite my hands."

It would be remarkable if *Theobaldia spathipalpis* should prove to be exclusively vegetarian in some localities, but a blood-sucker in others.

Believe me,
Yours very truly,
(Signed) E. E. Austen.

Captain J. Crawford Kennedy,
R.A.M.C.

In view of these observations, numerous attempts were made to induce female *Theobaldia*, some captured and others bred in captivity, to bite infected guinea-pigs, but with negative results. Neither could they be persuaded to bite either monkeys or man.

(b) *Culex fatigans* and *Culex pipiens*.—For all practical purposes these two species are identical, and in breeding out in the Laboratory no attempt was made to differentiate between them.

Very few experiments were made with these mosquitoes, as it was

a matter of the greatest difficulty to induce them to feed on the guinea-pig in the first instance, or on the monkey in the second. Further, whilst on the one hand no infection resulted, on the other no proof of the infective character of the mosquito was forthcoming, as plate cultivations of the stomach contents were omitted—consequently the experiments referred to were worthless.

(c) *Anopheles maculipennis.*—No experiments were made with this mosquito, as its only breeding place is situated in a small, almost uninhabited valley in the centre of the island, and the imagines are not met with elsewhere than in its immediate vicinity. It is therefore obvious that this mosquito can have next to nothing to do with the dissemination of *M. melitensis.*

7. *Biting Flies*—Stomoxys calcitrans.

Although the experiments of Edmond and Etienne Sergent* have shown that *Stomoxys* does not usually act as the infective agent concerned in the transmission of the trypanosome of North African camel disease, the fact that one successful infection in the rat was produced through the medium of this fly, encouraged the hope that in the case of such a minute coccus as *M. melitensis* success might attend experiments in the direction of transmission of the micrococcus to the goat by means of this biting fly.

(a) *Duration of Life of* M. melitensis *in* Stomoxys calcitrans.—As in the case of the mosquito, an inquiry was first made into the ability of *Stomoxys* to act as the host to *M. melitensis*, and the experiments were conducted on identical lines. Abundant supplies of *Stomoxys* were readily obtained from stables, so that it was unnecessary to breed them. When captured they were placed in a fair-sized gauze-covered cage, brought up to the Laboratory, and, as the insects were for the most part caught whilst feeding on the horses or mules, they were usually kept for a day before using to enable them to dispose of the blood with which they were filled. They were then transferred singly to feeding-tubes similar to those used for mosquitoes.

A guinea-pig was then infected, and when its blood was crowded with the micrococci, flies, each enclosed in a feeding-tube, were applied in turn to an area of skin denuded of hair and allowed to fill themselves with blood.

It was soon found that the wastage from death was excessive unless these insects were fed every 24 hours; this necessitated feeding the balance left over after every plating period on a healthy guinea-pig every day, but even this plan did not entirely prevent the heavy mortality.

At varying intervals several flies were killed by ether vapour, dis-

* 'Annales de l'Institut Pasteur,' vol. 19, 1905, pp. 16 *et seq.*

sected, the contents of the stomach and intestines plated out, and the resulting colonies of *M. melitensis* enumerated.

Plate cultivations were also established from the droppings, and it was found that, as in the mosquito, the excrement contained numerous living *M. melitensis* for many hours after feeding upon the infected guinea-pig.

In the following table the results of a number of these experiments are arranged, and from that it will be seen that although the micrococcus has sometimes disappeared entirely from the alimentary tract within a couple of days, it may persist even up to five days.

Table XXVIII.—*Stomoxys calcitrans* as the Host of *M. melitensis*.

No. of series.	Source of infection.	Interval between primary feeding and dissection.	Number of Stomoxys dissected and plated.	Average number of *M. melitensis* per stomach and intestines.
I	Guinea-pig No. 72	15 hours	1	197
		24 "	1	nil
		36 "	1	19
		60 "	6	136
II	Guinea-pig No. 82	15 minutes	2	832
		24 hours	1	5
		48 "	1	nil
		72 "	1	nil
		96 "	1	nil
III	Guinea-pig No. 111	15 minutes	2	347
		18 hours	2	17
		40 "	2	5
		97 "	2	2
IV	Guinea-pig No. 122	15 minutes	5	2,248
		24 hours	3	nil
		48 "	3	nil
		86 "	3	nil
		100 "	3	400
V	Guinea-pig No. 150	2 hours	3	912
		90 "	2	nil
VI	Guinea-pig No. 162	1 hour	2	3300
		48 hours	2	nil
		120 "	6	50,352

(*b*) Stomoxys calcitrans *as the Infective Agent.*—The experiments in which infected Stomoxys were allowed to bite healthy animals were conducted on similar lines to the corresponding experiments with mosquitoes. Two points of difference only need noting.

In the first place, the kid which previous experiments had shown (*vide*

Table XXIX.—Transmission of *M. melitensis viâ* Stomoxys.

Infective agents.				Experimental animals.			
Source of infection.	Average number of *M. melitensis* per control *Stomoxys* immediately after primary feeding.	Interval between primary feeding and biting the kid.	Number of *Stomoxys* employed in the experiment.	Animal and No.	Date of appearance of serum reaction.	Duration of experiment in days.	*Post-mortem* findings.
Guinea-pig No. 72...	197	20	4	Kid No. 1 ...	—	70	nil
Guinea-pig No. 122...	2,000	20	9	Kid No. 2 ...	—	28	nil
Guinea-pig No. 122...	2,000	44	6	Kid No. 3 ...	—	27	nil
Guinea-pig No. 122...	2,000	112	3	Kid No. 6 ...	—	35	nil
Guinea-pig No. 162...	3,000	24	12	Kid No. 7 ...	—	9	nil
Guinea-pig No. 162...	3,000	48	6	Kid No. 8 ...	—	42	nil
Guinea-pig No. 162...	50,352	96 102 120	6 5 6	Kid No. 15 ...	—	40	nil

pp. 30 and 34) was extremely susceptible to subcutaneous and cutaneous inoculation, replaced the monkey as the experimental animal; and in the second place the infected *Stomoxys* were fed upon the healthy guinea-pig in the intervals between feeding on the kid. The results may be very briefly stated. In all, seven experiments were carried out, and in no case did infection of the kid with *M. melitensis* ensue, although in one of the experiments a kid was bitten by three separate batches of six, five, and six *Stomoxys* respectively during a period of 24 hours, at intervals of 96, 102, and 120 hours after the primary feeding on the infected guinea-pig. The details of these experiments are arranged in tabular form under the same headings as those used for the corresponding mosquito experiments on pp. 90 and 93.

8. *Fleas and Bugs.*

The experiments carried out with blood-sucking Hemiptera and Aphaniptera were few in number and of very questionable value, even when considered in relation to the negative evidence they produced, and may be very briefly dismissed.

Hemiptera—*Cimex lectularia.*—In view of the suggested association between certain cases of Malta Fever and venereal disease referred to by Kennedy* and the possibility of the infective virus being conveyed by domestic vermin, some 50 ordinary bed bugs were collected from low class brothels in the vicinity of the Camerata, Valletta, conveyed to the Laboratory and there killed and dissected. The stomach contents of each were then plated out in turn, but *M. melitensis* was never detected in, or isolated from, this situation. These were the only observations made with this parasite.

Aphaniptera (a) *Pulex irritans.*—No observations were made upon the human flea.

(b) *Pulex serraticeps.*—Dog fleas to the number of six were collected from a dog (which had been experimentally infected with *M. melitensis* by subcutaneous inoculation), killed, dissected, and plated, but no evidence could be obtained to show that they harboured the micrococcus.

(c) *Pulex scuirorum.*—Again 14 rat fleas were obtained from various rats which had been experimentally infected with *M. melitensis*, and in whose blood *M. melitensis* was swarming. After being similarly dissected the plate cultivations established from the stomach contents likewise failed in every case to show the presence of the coccus.

Two experiments were made in an endeavour to transmit *M. melitensis* from infected to healthy dogs through the agency of the flea:—

1. A healthy black terrier dog was inoculated subcutaneously

* Kennedy, 'Journ. Royal Army Med. Corps.,' vol. 4, 1905, p. 634.

behind the shoulder with emulsion containing the growth from three agar tubes of *M. melitensis*. Three weeks later the animal, which had in the interval shown definite signs of infection, was killed with chloroform vapour and the dead body placed close to, but not in contact with a bitch of the same variety for a period of 24 hours, in the hope that infected fleas would pass from the dead body as it cooled to the warm body of the living animal and so transmit the infection. *M. melitensis*, however, was only isolated *post mortem* from the inguinal and mesenteric glands of the terrier dog—not from the blood. The bitch never showed any sign of infection during an observation period of two weeks, and at the end of this time the second experiment was proceeded with.

2. Another black terrier dog which had been inoculated with a similar dose of *M. melitensis* six weeks previously, and like the first dog had given definite evidence of infection, was killed and placed alongside the same terrier bitch that had been utilised for the first experiment, for about 14 hours—precautions being taken to prevent contact of the healthy bitch with either carcase or excrement of the infected animal. This second dog when examined *post mortem* gave evidence of the presence of *M. melitensis* in spleen, inguinal and axillary glands, but the coccus was again absent from the blood.

The bitch never showed any signs of infection.

These two experiments are of course valueless from the scientific point of view, as the evidence available points to the absence of micrococci from the blood of the infected animal at the time of death, even supposing the dog fleas travelled from the carcase to the body of the living bitch.

Some further experiments were then made on somewhat similar lines with the rat flea. The rat had always been considered by the early workers with *M. melitensis* as insusceptible to infection with this organism, but it was observed by one of the members of the Commission that the rat, after intracranial inoculation, dies from acute septicæmia in about 24 hours, the micrococcus being present in the blood in enormous numbers for at least the last 12 hours of life; while after a few intracranial passages the coccus becomes exalted in virulence for this particular animal and readily produces an acute septicæmia after either intraperitoneal or subcutaneous inoculation. Consequently in investigating the probability of the transmission of *M. melitensis* from the infected to the healthy rat, these highly virulent cultures were utilised.

In arranging these experiments, long rat cages were selected and divided into three compartments, a fair-sized one at either end, and a small narrow one in the centre, by means of two wire-netting partitions placed about 6 cm. apart. The meshes of the wire netting forming the partitions were about 0·5 cm. in diameter.

A couple of infected white rats were placed in one end compartment and two healthy rats in the other; all four rats were infested with large and vigorous fleas. The cage was then placed in a large rectangular zinc tray filled with lysol solution almost to the level of the floor of the cage. In the first experiment the infected rats died within 18 hours, and on the morning following the commencement of the experiment it was found that the other two rats had partly broken down the partitions and were occupying the same compartment as the dead rats.

The infected animals examined *post mortem* were noted to be quite free from fleas. The blood of each was crowded with the micrococci, as were spleen, kidneys, and all other organs.

The healthy rats died six hours after the infected animals, and at the *post-mortem* examination, which was conducted at once, no fleas could be found on the carcases, although shortly before death the animals were simply swarming with them. Many dead fleas were, however, found in the lysol moat surrounding the cage. From the *post-mortem* examination no evidence of infection could be obtained, as *M. melitensis* could not be detected in, or isolated from any of the tissues or organs.

This experiment was repeated a fortnight later in precisely the same manner.

Again the infected rats soon succumbed—one within nine hours, its companion within 22 hours after inoculation. No fleas could be detected on the carcases and no dead fleas were present in the lysol. *Post-mortem* blood and organs were crowded with micrococci.

The healthy rats were killed with chloroform seven days later and examined at once. Specific agglutinins were absent from the blood of each. Plate cultures from the blood and various organs failed to show any colonies of *M. melitensis*, neither could the micrococcus be detected in the bodies of the fleas caught on the bodies of these rats.

In both these experiments the *M. melitensis* was undoubtedly present in the infected rats, and the fleas upon them in all probability absorbed the cocci with the blood of their hosts. Further, it is a matter of common knowledge that fleas forsake the bodies of dead or dying rats for healthy living members of the same species, and in these experiments should have had ample opportunity of biting the healthy rats in the further compartment. Yet in neither of the four rats exposed to bites from presumably infected fleas did infection with *M. melitensis* ensue and the results were absolutely negative.

V.—Naturally Acquired Infection (*M. melitensis*) in Various Animals.

During 1905 numerous observations were carried out upon various animals during life to determine whether infection with *M. melitensis*

occurred naturally. These observations were usually limited to an examination of the blood for *M. melitensis* agglutinins, but were followed in a few cases by *post-mortem* examination. As a result of these examinations, it was clearly shown that cows and dogs living in the Island acquired naturally an infection with *M. melitensis*, while from the presence of positive serum reactions in low dilutions, it was suggested that mules were also susceptible to the pathogenic action of the coccus.

Similar observations were continued during the summer of 1906, as many various species of animals being examined as opportunity permitted, and the results noted are here recorded.

1. *Rats.**—The close association of epizootic plague in the rat and epidemic plague in man suggested the possibility of a similar association between the rat and Malta Fever, but inquiry amongst residents in the Island failed to support this view.

Arrangements were then made for the supply of sewer rats from the dockyard and from the Valletta sewers for examination in the Laboratory. Owing, however, to the frequent and prolonged absence of the Fleet from Malta, the number of rats obtainable from the dockyard was small; it also proved a matter of greater difficulty to obtain the rodents from the Valletta sewers, even a capitation fee of 3*d.* per head failing to secure the necessary material, so that a total of 84 rats examined during the months of May, June, and August is all that could be obtained. During May and June, the rats on arrival at the Laboratory were sorted out into cages and numbered, and blood collected from each to afford serum for the agglutination reaction, and also for planting out for the recovery of *M. melitensis*, and it was intended that a complete *post-mortem* examination should be made only when specific agglutinins were detected in the blood.

Table XXX.—Examination of Sewer Rats.

Month, 1906.	Number of rats examined.	Serum reaction.	*M. melitensis* in	
			Blood	Other organs.
May............	72	Absent	Absent	Not examined.
June	6	”	”	”
July	0	—	—	—
August	8	Absent	Absent	Absent

In July no sewer rats at all could be obtained, but during that month experiments were carried out which showed that while the rat was susceptible to infection with the micrococcus, agglutinins were not usually formed during the course of the disease, and consequently a

* Compare these Reports, V, p. 40.

complete *post-mortem* was performed on the eight rats that were available during August.

The results of these examinations were completely negative. None of the specimens of rat blood that were examined yielded an agglutination reaction even in low dilutions, and *M. melitensis* was never recovered from blood or organs.

Several dozen white rats, bred on the Island and purchased for experimental work, were also tested before use as to the presence of the serum reaction to *M. melitensis*, likewise with negative results.

2. *Dogs.**—Forty-six stray dogs were examined between the beginning of March and the end of August for the presence of *M. melitensis*, and of these three yielded a positive reaction—one in dilution of 1 in 10, one in dilution of 1 in 20, and a third in all dilutions up to 1 in 100. Although a reaction obtained in a dilution of 1 in 20 is by no means absolute or even satisfactory evidence of infection, all three of these animals were killed and examined *post mortem*, but *M. melitensis* was never recovered from any of the organs or tissues.

Table XXXI.—Examination of Stray Dogs.

Month.	Number of dogs examined.	Serum reaction.	*M. melitensis* in	
			Blood.	Other tissues and organs.
March	10	1 × 1 in 10	Not examined	Not examined.
April	13	Absent	,,	,,
May	0	—	,,	,,
June	0	—	,,	,,
July	0	—	,,	,,
August	23	1 × 1 in 20	Absent	Absent
		1 × 1 in 100	,,	,,

3. *Guinea-pigs.*—The numerous guinea-pigs employed in the experimental work were all bred on the Island, and as a preliminary precaution the blood was carefully examined in many different dilutions with reference to the presence of specific agglutinins. These substances, however, were invariably absent from the blood.

4. *Mules.**—Some mules were imported into Malta from Sicily at the beginning of 1906. Steps were taken to examine their blood as soon as possible after arrival. As a result of this examination the blood from each of these mules yielded a partial or incomplete reaction with serum in low dilution (1 in 10), but no reaction whatever could be obtained in higher dilutions.

Six months later the blood from these same nine mules was again

* Compare these Reports, III, p. 85 *et seq.*

Table XXXII.—Examination of Mules.

No. of mule.	Date of arrival in Malta.	Date of first examination.	Agglutination value of mule's serum.	Nature of sickness, if any, recorded between February and August, 1906.	Date of second examination.	Agglutination value of mule's serum.
48,396	19/2/06	15/3/06	1 : 10 ±	Girth gall	28/8/06	1 : 200 +
48,397	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	1 : 10 +
48,398	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	nil
48,399	19/2/06	15/3/06	1 : 10 ±	Girth gall : swollen sheath	28/8/06	1 : 10 ±
48,400	19/2/06	15/3/06	1 : 10 ±	Castration	28/8/06	nil
48,401	19/2/06	15/3/06	1 : 10 ±	Set fast	28/8/06	1 : 500 +
48,402	19/2/06	15/3/06	1 : 10 ±	Breast harness gall	28/8/06	1 : 10 ±
48,403	19/2/06	15/3/06	1 : 10 ±	Sore breast : lame	28/8/06	1 : 200 ±
48,404	19/2/06	15/3/06	1 : 10 ±	Nil	28/8/06	1 : 500 ±

examined, with the result that one reacted well and one incompletely in dilution of 1 in 500; two others reacted, one completely and one incompletely in dilutions of 1 in 200. The serum reactions of the remaining mules remained practically unaltered.

Judging these results from the alteration in their serum values, it is practically safe to assume that two of the mules (Nos. 48,401 and 48,404) had acquired *M. melitensis* infection during the course of their first summer in Malta, and probably Nos. 48,396 and 48,403 had also become infected. The absence of any serious sickness in these animals needs no comment in view of the lack of constitutional symptoms in the infected goats. Unfortunately, *post-mortem* examination of these animals was not possible. The results of these examinations are given in Table XXXII.

5. *Horses.*—In order to obtain some idea as to the prevalence of *M. melitensis* infection in the horse—as judged by the serum reaction standard—samples of blood from 100 horses attached to the Mounted Infantry camp at Ghain Tuffeiha were examined.

The results obtained were as follows :—

Negative reaction				54
Incomplete reaction	in	1 in 10	dilution	14
Complete	”	”	”	11
Incomplete	”	1 in 20	”	11
Complete	”	”	”	7
Incomplete	”	1 in 50	”	2
Complete	”	”	”	1
				100

It will thus be seen that the agglutination reaction was obtained in varying dilutions in 46, the test proving absolutely negative in 54. In 14 of those animals yielding a reaction of some sort, the result of the test was "incomplete," clumping with 1 in 10 dilutions, and as such a reaction is valueless as evidence of infection, these animals may be disregarded. Again, neither a complete reaction in a dilution of 1 in 10, nor an incomplete reaction in dilution of 1 in 20 can be regarded as incontrovertible evidence, and at any rate, in the case of the human subject, neither would be accepted as deciding a question of diagnosis. Eliminating such animals as did not give a positive reaction in at least as high a dilution as 1 in 20—and even this standard is open to question—10 animals are left which show signs of infection by *M. melitensis*, three, indeed, in a marked manner. Unfortunately, no further examination of these infected animals was possible.

One of the animals (No. 95) was subsequently shot, and examined *post mortem*. During life the titre of its serum, when tested against

Table XXXIII.—Examination of Horses.

Serial No.	Service in Malta.	Agglutination value of serum.	Previous medical history.	Present condition.
6	2 years	1 : 10 ±	Nil	Good
25	5 ,,		One attack colic	Good
27	5 ,,		Nil	Good
42	5 ,,		Two attacks colic: one attack catarrh	Good
98	5 ,,		Nil	Good
113	—		—	—
117	5 years		One attack catarrh	Good
119	5 ,,		Nil	Good
120	5 ,,		Nil	Good
125	2 ,,		Nil	Fair
126	2 ,,		Nil	Good
138	1 year		Nil	Good
140	4 years		Two attacks colic: one attack horse-pox	Good
145	1 year		One attack diabetes	Poor
2	6 years	1 : 10 +	One attack stomatitis	Fair
23	6 ,,		Nil	Good
30	5 ,,		Two attacks colic	Fair
43	2 ,,		Nil	Good
72	6 ,,		One attack catarrh	Fair
75	6 ,,		Nil	Good
95	6 ,,		Nil	Good
103	5 months		Nil	Fair
114	6 years		Nil	Good
130	5 months		Nil	Good
137	5 ,,		Nil	Fair
9	6 years	1 : 20 ±	Nil	Good
18	6 ,,		One attack catarrh	Fair
22	6 ,,		Nil	Good
56	6 ,,		Nil	Good
58	5 ,,		Nil	Good
59	5 ,,		Nil	Good
61	5 ,,		One attack strangles	Good
70	5 ,,		Nil	Good
82	6 ,,		Nil	Good
91	5 ,,		One attack catarrh	Good
127	6 ,,		One attack catarrh	Fair
37	6 ,,	1 : 20 +	One attack pink eye	Good
38	2 ,,		Nil	Good
66	6 ,,		Nil	Good
71	6 ,,		Nil	Good
115	6 ,,		Two attacks catarrh	Good
129	6 ,,		Two attacks debility	Fair
143	1 year		Nil	Fair
64	2 years	1 : 50 ±	Nil	Good
74	6 ,,		Nil	Good
94	6 ,,	1 : 50 +	Nil	Good

M. melitensis, was 1 in 10. The micrococcus could not, however, be detected in either blood, spleen, or inguinal or mesenteric glands. Three other horses (Nos. 11, 35, and 52), whose blood during life showed no signs of the presence of agglutinins, were examined *post mortem*, but with completely negative results so far as related to the presence of *M. melitensis*.

Details of the animals, relating to the length of service in Malta with the Mounted Infantry, their present condition, and previous medical history, were kindly supplied by the commanding officer, Captain Salmon, and such of those details as refer to horses that gave a serum reaction are given in Table XXXIII.

VI.—*M. melitensis* Infection by Means of Personal Contact.

The incidence of Malta Fever upon cases admitted to naval and military hospitals for venereal disease, although probably due to infection by means of the goats' milk that forms the staple article of diet of the men during the first days of treatment, at once raises the suggestion that simultaneous infection might occur during sexual connection through minute lesions of the mucous membrane of the glands or prepuce, especially when considered in conjunction with the existence of *M. melitensis* in the urine of so-called ambulatory cases of the disease. In these latter cases febrile disturbance is extremely slight or entirely absent, as indeed are clinical symptoms of any kind, although at the same time the patient, male or female, may be passing *M. melitensis* in thousands per cubic centimetre in the urine.

Writing in the 'Journal of the Royal Army Medical Corps,'* Kennedy stated that of the cases which developed Malta Fever after admission to the military hospital for some other disease, by far the larger proportion were venereal cases. The experience of the authorities at the Royal Naval Hospital appears to be very similar.

Following up this line of enquiry, the before-mentioned observer collected in 1905, and followed out, a series of 124 cases, 20 of which had been under treatment for venereal disease during some portion of the couple of months preceding the diagnosis of Mediterranean Fever. Again, of these 20 cases the probability of infection contracted within the hospital could be excluded with tolerable accuracy in 12, viz., 6 cases of gonorrhœa, 1 of soft sore, and 5 of syphilis.

Under these circumstances an enquiry was instituted into the medical history of the common prostitutes of Malta. The investigation was much facilitated owing to the fact that the bulk of these women are Italians or Sicilians and, therefore, coming under the law with regard to aliens, are registered by the police, their addresses are known, and a

* Kennedy, J. C., "Malta Fever in the Military Hospital, Valletta, Malta, during the years 1897—1904," 'Journ. R.A.M.C.,' vol. 4, 1905, pp. 634—646.

Table XXXIV.—Positive Results of Agglutination Test.

No.	Initials.	Duration of residence in Malta.	History of attack of Malta Fever.	Serum value.					
				1 : 5.	1 : 10.	1 : 20.	1 : 50.	1 : 100.	1 : 200.
94	N. A.	9 months	Negative	+	±	–	–	–	–
95	C. A.	20 "	"	+	±	–	–	–	–
96	R. A.	1 year	"	+	±	–	–	–	–
97	C. C.	20 months	"	+	±	–	–	–	–
98	C. C.	?	"	+	±	–	–	–	–
99	A. C.	3 months	"	+	±	–	–	–	–
100	V. C.	4½ years	"	+	±	–	–	–	–
101	R. C.	1½ "	"	+	±	–	–	–	–
102	C. G.	4½ "	"	+	±	–	–	–	–
103	A. M.	7 "	"	+	±	–	–	–	–
104	E. R.	6 "	"	+	±	–	–	–	–
105	V. T.	3 months	"	+	±	–	–	–	–
106	D. A.	2 years	"	+	+	–	–	–	–
107	C. C.	Native	"	+	+	–	–	–	–
108	G. C.	"	Oct. to Dec., 1905	+	+	–	–	–	–
109	G. N.	12 years	Negative	+	+	–	–	–	–
110	A. S.	?	"	+	+	–	–	–	–
111	C. B.	5 months	"	+	+	+	–	–	–
112	C. B.	Native	"	+	+	+	–	–	–
113	G. C.	9 months	"	+	+	+	–	–	–
114	M. C.	16 years	"	+	+	+	–	–	–
115	F. D.	1½ "	"	+	+	+	–	–	–
116	R. G.	9 months	"	+	+	+	–	–	–

117	G. L.	1¼ years	,,	+	+	+	—	—	—
118	C. M.	Native	,,	+	+	+	—	—	—
119	R. M.	,,	,,	+	+	+	—	—	—
120	R. T.	5 years	*	+	+	+	—	—	—
121	G. T.	6 ,,	Negative	+	+	+	—	—	—
122	G. C.	4 ,,	,,	+	+	+	+	—	—
123	A. C.	Native	,,	+	+	+	+	—	—
124	F. C.	,,	,,	+	+	+	+	—	—
125	G. D.	5 years	,,	+	+	+	+	—	—
126	M. D.	3 ,,	,,	+	+	+	+	—	—
127	G. S.	6 ,,	,,	+	+	+	+	—	—
128	F. S.	1½ ,,	,,	+	+	+	+	—	—
129	C. G.	Native	Sept. to Dec., 1904	+	+	+	+	+	—
130	A. M.	,,	Negative	+	+	+	+	+	—
131	A. M.	3½ years	,,	+	+	+	+	+	—
132	A. T.	2 months	,,	+	+	+	+	+	—
133	F. T.	10 years	,,	+	+	+	+	+	—
134	B. A.	5 months	Jan., 1906	+	+	+	+	+	+

* Rheumatism (?) March, 1906.

tri-monthly medical examination is carried out by certain district medical officers.

Preliminary enquiries elicited a definite history of an attack of Malta Fever varying in duration from two to twelve weeks in 3, and a history of "rheumatism" suspiciously like the neuritis associated with the Fever in 1, out of a total of 147 registered women. Next, specimens of blood were collected from 134 of those previously interviewed—the remaining 13 refusing to allow either finger or ear to be pricked in order to obtain samples—for the purpose of carrying out the agglutination test. Of these 134, 93 (or 69·4 per cent.) gave a completely negative reaction, 12 (or 8·95 per cent.) a slight reaction, indicating probably either a recent extremely mild or very remote attack of Malta Fever, and 29 (or 21·64 per cent.) yielding reactions that pointed to present or recent more severe infections.

Combining these two latter classes, it will be seen that no less than 41 out of a total of 134, or 30·59 per cent., exhibited evidence of *M. melitensis* infection.

The next step was to obtain vaginal swabbings and specimens of urine from such of the prostitutes as yielded a positive serum reaction and, by means of plate preparations, endeavour to determine the presence or absence of *M. melitensis* from these situations.

Of the 41 women yielding positive serum reactions, five, finding their occupation gone owing to the absence of the Fleet from Malta, returned to their homes in Sicily, and further specimens could not be obtained from them; four more absolutely refused to permit swabbings or specimens of urine to be taken; the remainder, 32 in number, afforded specimens for examination on one, two, or three several occasions.

In the collection of these specimens the vaginal swabbings were taken on ordinary sterile swabs such as are employed for collecting diphtheritic material (a piece of absorbent wool twisted round the end of a 15-cm. length of iron wire, enclosed in a test-tube, and the whole sterilised by dry heat), from just within the vaginal orifice or from some portion of the lower third of the vaginal wall. A Sims speculum was then passed into the vagina and the mouth of the os uteri exposed, and some of the cervical mucus collected on other sterile swabs. With regard to the urine samples, it was rarely possible to obtain catheter specimens, and, consequently, after the vaginal swabbing had been taken, a sterile, wide-mouthed bottle was handed to the woman and she was instructed to pass water directly into it. In this way, although asepsis was somewhat neglected, specimens of urine remarkably free from extraneous germs were usually obtained.

On arrival at the Laboratory, plate cultivations were prepared from each of the specimens as follows:—

Vaginal or Cervical Swabbing.—With a pair of sterile forceps the end

of the swab wire was bent up at right angles so as to form an L-shaped rod, the infected cotton-wool occupying the short arm. Using the instrument now as a spreader, the swabbing was smeared over the surface of three nutrose agar plates in succession, and the plates numbered in the order of their inoculation.

Urine.—(*a*) One-tenth of a cubic centimetre of the urine sample was evenly distributed over the surface of each of four nutrose agar plates by means of a sterile L-shaped glass rod.

(*b*) Twenty cubic centimetres of the urine sample were transferred to a sterile centrifuge tube and thoroughly centrifugalised. Nearly all the supernatant fluid was pipetted off and the deposit shaken up with the remaining half cubic centimetre of urine, taken up in a sterile pipette and divided between two Petri dishes of nutrose agar. By means of a glass spreader, the urine deposit was distributed all over the surface of the first plate, and with the same instrument two further nutrose plates were inoculated in series. The remainder of the urine deposit, placed on the second plate, was distributed over it in like manner by the help of a second spreader, and two further plates inoculated in series with it.

After inoculation and labelling with distinctive number, etc., all the plates were transferred to the incubator at 37° C., and kept under observation up to the end of seven days. All suspicious colonies were tested by means of a serum of high titre, and those reacting were verified by tinctorial and cultural tests.

The details of the examinations are given in tabular form (p. 112), but the results may be briefly summarised as follows:—

(1) *Urine.*—*M. melitensis* recovered on five occasions from four patients.

(2) *Cervical Mucus.*—*M. melitensis* never recovered from this situation.

(3) *Vaginal Swabbings.*—*M. melitensis* recovered on two occasions from one patient convalescent from an attack of Malta Fever, and on one occasion from a patient who had suffered from a severe attack 18 months previously.

In connection with the isolation of *M. melitensis* from vaginal swabbings, it is interesting to note that the micrococcus was isolated from the the same situation, and also from the milk and the urine in the case of a married woman, Mrs. A., about a week after her discharge as convalescent from the Married Families (Military) Hospital at Valletta.

In view of the foregoing results an attempt was made to determine experimentally the possibility of infection taking place through the genital mucous membrane—a possibility which was rendered the more probable by reason of Shaw's successful infections through the apparently intact conjunctival mucous membrane (see these Reports, V, p. 10).

Table XXXV.—Examination of Urine, etc.

No. (*cf.* Table XXXIV).	Initials.	Urine.		Vaginal swabbings.		Cervical mucus.	
		No. of examinations.	*M. melitensis* recovered.	No. of examinations.	*M. melitensis* recovered.	No. of examinations.	*M. melitensis* recovered.
94	N. A.	3	0	3	0	2	0
95	C. A.	1	0	1	0	1	0
100	V. C.	3	0	3	0	2	0
101	R. C.	3	0	3	0	2	0
103	A. M.	3	0	3	0	2	0
104	E. R.	1	0	1	0	1	0
106	D. A.	2	0	2	0	1	0
107	C. C.	3	0	3	0	2	0
108	G. C.	1	0	1	0	1	0
109	G. N.	2	0	2	0	2	0
111	C. B.	1	0	1	0	1	0
112	C. B.	2	0	2	0	2	0
115	F. D.	2	0	2	0	1	0
116	R. G.	1	0	1	0	1	0
117	G. L.	2	0	2	0	2	0
118	C. M.	2	0	2	0	2	0
119	R. M.	3	0	3	0	3	0
120	R. T.	2	0	2	0	1	0
121	G. T.	2	0	2	0	1	0
122	G. C.	1	0	2	0	1	0
123	A. C.	2	0	2	0	2	0
124	T. C.	1	0	1	0	1	0
125	G. D.	1	1	1	0	1	0
126	M. D.	2	0	2	0	1	0
127	G. S.	3	0	2	0	1	0
128	F. S.	2	0	2	0	2	0
129	C. G.	1	1	1	1	1	0
130	A. M.	3	0	3	0	2	0
131	A. M.	2	0	2	0	2	0
133	F. T.	2	2	2	0	1	0
134	B. A.	2	1	2	2	2	0

A prolonged search was first made for an infected milch goat which should combine the two factors—readiness for impregnation and the excretion of urine containing *M. melitensis*—but without success; consequently the demonstration of the infection of the healthy male goat as a sequent to covering the suitable infected female had perforce to be abandoned. Monkeys were available but proved refractory owing to the vicious nature of the females, and pairing was unsuccessful. Finally, two healthy male monkeys were selected; first one and then the other was securely held on the operating table, the glans penis exposed and carefully examined with a hand lens for scratches and abrasions. As the mucous membrane in each case appeared to be intact, the following experiments were made:—

(1) A strip of cotton-wool was first dipped in a fresh specimen of urine from an ambulatory case of Malta Fever (under observation in H.M. Naval Dockyard), then wrapped around the glans penis of Monkey No. 203 and left in contact with the mucous membrane for a period of half a minute. The wool was then removed, the glans mopped dry with sterile cotton-wool and the monkey returned to his cubicle.

The specimen of urine was then plated out and the subsequent growth showed the presence of 500 colonies of *M. melitensis* per cubic centimetre.

On the 17th day the blood serum of Monkey No. 203 in dilution of 1 in 20 caused typical clumping of *M. melitensis*. The titre of the serum gradually rose until on the 28th day it had reached 1 in 150. The animal was then killed with chloroform vapour, and at the *post-mortem* examination the micrococcus was recovered in large numbers from right and left inguinal glands, and in smaller numbers from the right axillary gland and the spleen, but was absent from the blood; the *post-mortem* also revealed the fact that this monkey was the subject of miliary tuberculosis.

(2) After exposing the glans of Monkey No. 200 it was first dried with sterile cotton-wool, and then a small area of the surface was rubbed with a dry, hard pad of sterile cotton-wool to produce a "friction" excoriation. A piece of wool soaked in the same specimen of urine that was used for the first experiment was wrapped around the glans and left in contact for 30 seconds. It was then removed, the glans dried and the monkey returned to his cage.

On the 17th day an agglutination reaction in dilution of 1 in 10 was obtained and by the 28th day the serum value had risen to 1 in 200. The animal was killed on this day and at the *post-mortem* the *M. melitensis* was recovered from the blood—to the number of about 10,000 per cubic centimetre—and in large numbers from the spleen, the axillary, inguinal, and mesenteric glands.

Both these experiments, therefore, yielded positive results, infection taking place in the first case by absorption of the coccus through an

Table XXXVI.—Infection of Monkey *viâ* Mucous Membranes.

No. of monkey.	Sex.	Condition of exposed surface of mucous membrane of glans penis.	Infective material.	Serum reaction.		Duration of experiment in days.	*Post-mortem* findings.							
								M. melitensis recovered from—						
				Day of appearance.	Amount of dilution.		Value of serum.	10 c. mm. of blood.	Axillary glands. R.	Axillary glands. L.	Inguinal glands. R.	Inguinal glands. L.	Mesenteric glands.	Spleen.
203	♂	Apparently intact.	Urine from ambulatory case of Malta Fever (1857), see p. 128	17	1 : 20	28	1 : 150	—	+	—	+	+	—	+
200	♂	Friction excoriation.	Ditto	17	1 : 10	28	1 : 200	1000	+	+	+	+	+	+

apparently uninjured and intact mucous membrane, and in the second case probably through the artificially produced lesion—in both the incubation period extended to 17 days, an interval between exposure to infection and the first appearance of symptoms which tallies very closely with those noted by Shaw in the experiments previously referred to.

VII. Prophylactic Inoculation with *M. melitensis* Vaccine.

The results that had attended the use of *M. melitensis* vaccine during the winter of 1905–6 by one of the members of the Working Party in the treatment of cases of Malta Fever after return to England, encouraged the hope that its employment as a prophylactic vaccine might be a measure of practical utility, and arrangements were made to put it to the test.

As the records of the Royal Naval Hospital at Bighi and of the R.A.M.C. Detachment in Malta showed an abnormally high case-incidence amongst those men whose duty it was to nurse Malta Fever patients, it was decided to limit the vaccination for the summer of 1906 to this section of the community. The plan being explained to the men, a sufficient number of the Sick Bay Staff and Nursing orderlies expressed their desire to submit to the inoculations, to admit of the full strength being divided into two nearly equal batches both at the Military and the Naval Hospitals—one section at each institution being untouched or injected merely with sterile saline solution to serve as controls.

The Subjects—Naval.—Of the staff of the Naval Hospital at Bighi, 43 men were available for observation in this connection, of whom 23 were vaccinated (7 on one occasion only and 16 on two occasions) and 20 were reserved as controls. From the 23 vaccinated men, however, two must be deducted, for the danger that must always exist in carrying out a series of vaccinations within the endemic area was here

Table XXXVII.—Incidence of Malta Fever on the Bighi Hospital Staff.

	1901.	1902.	1903.	1904.	1905.	1906, Jan.—April.
Members of Sick Berth Staff exposed to infection	31	51	65	75	80	43
Number contracting Malta Fever........................	5	19	12	16	12	13

encountered and two of the men were vaccinated—each with a dose of 200 millions of cocci—during the *incubation period* of the

naturally acquired disease. This leaves 21 inoculated men and 20 controls who were under observation from April 27th to August 30th, 1906. During this period one of the controls contracted the disease, but no cases occurred amongst the vaccinated men.

The incidence of Malta Fever on the Sick Berth Staff during previous years is shown in Table XXXVII.

Military.—The strength of the Valletta detachment of the Royal Army Medical Corps (R.A.M.C.) at the commencement of the experiment comprised 84 men, of whom 12 had already suffered from an attack of Malta Fever, and four were then in hospital. This left a balance of 68 available for the purposes of observation. Of these 30 volunteered for inoculation, the remaining 38 served as controls. The fallacies involved in such a division have already been threshed out in connection with prophylactic inoculations of typhoid vaccine, and need not be further enlarged upon here. Suffice to say, that of the inoculated men 15 received one injection only, and 15 received two injections; and during the four months, from April 26 to August 30, 1906, that the men were under the observation of the operator, two cases occurred amongst the non-vaccinated controls, and none in the vaccinated men.

At the beginning of September, however, two cases occurred in the vaccinated men. The first, Lance-Corporal Johnson, assistant in the Commission Laboratory at Valletta, who had been injected twice with a dose of 400 millions of cocci on each occasion, and whose serum value had reached 1 in 50, suffered a typical attack, and the second, Private Boyd, who had been inoculated once only with a similar dose, and whose serum had a value of 1 in 30.

Owing to the distribution of the units of the detachment over the whole island for duty at the various military hospitals, and the frequent changes of station that take place, it is difficult to tabulate the incidence of Malta Fever in that portion of the detachment stationed at Valletta Hospital. Dealing, however, with the period January 1 to April 30, 1906, in an average strength of 81 (including 12 who had already suffered from the disease), five cases of Malta Fever occurred, whilst during the period May 1 to August 21, 1906, with a strength similar in numbers and composition, only two cases, both in non-vaccinated controls, occurred.

The Vaccine.—The vaccine employed was the remainder of a batch prepared and bulbed on March 16, 1906, in the Bacteriological Department of Guy's Hospital. The method of preparation varied in no respect from that usually adopted, and may be briefly described, first premising that all apparatus and solutions employed must be absolutely sterile, and every operation carried out under strictly aseptic conditions and with every possible precaution to avoid the entrance of extraneous micro-organisms.

A virulent culture of *M. melitensis* direct from the spleen of a

guinea-pig, dead from *M. melitensis* septicæmia within 24 hours of intracerebral inoculation, is carefully emulsified in about 5 c.c. of sterile saline solution and transferred to the glass reservoir of an aseptic "laryngeal spray." By means of this little spraying apparatus the emulsion is evenly distributed over the surface of the "optimum" reaction (+8) agar contained in each of several culture bottles of either the Roux or the Kolle pattern. After insemination the culture bottles are incubated aerobically at 37° C. for from 24 to 36 hours. At the end of the incubation period the growth in the culture bottles is examined visually to determine its freedom from gross contamination; by means of stained preparations to determine its purity; and by the agglutination test with serum of high titre to determine its identity. The culture proving satisfactory, 5 c.c. of a 0·1-per-cent. saline solution are pipetted into each bottle, and by means of gentle agitation caused to take into suspension the upper layers of micrococci in the growth.

The turbid fluid is then pipetted off into a flask, which is labelled "A," and which receives in turn the surface washings from each of the culture bottles. A further 5 c.c. saline solution is introduced into the culture bottle, and the remainder of the growth is emulsified as evenly as possible with the help of a curved glass or platinum rod; this very turbid emulsion is transferred to a second flask labelled "B," containing a number of glass beads. When this process has been repeated with all the rest of the culture bottles and the emulsion added to that already in the flask with the beads, the flask with its contents is vigorously shaken at short intervals during the next half hour or so in order to disintegrate as far as possible any clumps of micrococci that may be present. The emulsion is then transferred to centrifugal tubes, placed in an electrical centrifuge, and run at a speed of some 2500 revolutions per minute for 30 minutes. At the end of this time a considerable deposit will have been thrown down, which is left behind in the tube, while the supernatant fluid is pipetted off and added to the surface washings from the culture bottles in the first flask. The centrifugal deposit is usually destroyed, but if a large quantity of vaccine is urgently required the deposit is returned to the flask "B," a few cubic centimetres of the saline solution added, and the shaking with the beads repeated. Further small quantities of saline solution are added from time to time during the process until an emulsion is formed which, to the naked eye, presents an opacity rather denser than that present in the emulsion in flask "A." This emulsion is again centrifugalised, and the supernatant fluid may be pipetted off and added to the emulsion in flask "A."

The emulsion in flask "A" is now ready for the enumeration of its contained micrococci, which is done by Wright's method if time is of supreme importance.

Wright's method consists of taking into a capillary Pasteur pipette, furnished with a rubber teat, three equal volumes of a solution containing 0·75-per-cent. sodium chloride and 1-per-cent. sodium citrate, one volume of normal blood direct from a needle puncture of the finger or ear (and assumed to contain 500 millions of red cells per cubic centimetre), and one similar volume of the emulsion of cocci. These various fluids are ejected from the pipette on to a slide and mixed thoroughly by repeatedly aspirating into and ejecting from the pipette; finally, the mixture is transferred to a clean slide, and with the help of a second slide a blood film is prepared in the usual way. This is stained by Jenner's or by Leishman's stain, and examined microscopically with a 1/12-inch objective; then by the enumeration of the red cells and of the micrococci respectively in a number of "fields" an average is struck for the ratio of the one to the other, and from this ratio is calculated the number of micrococci present per cubic centimetre of the emulsion.

Whenever possible it is desirable to control this method by ordinary plating methods—after such dilution of the emulsion as may be deemed necessary—incubating for three days at 37° C., and enumerating the resulting colonies by the help of a counting disc.

Whilst the enumeration is in progress the emulsion is distributed, in quantities of 10 c.c., in as many sterile test-tubes plugged with cotton-wool as may be necessary; the tubes are then suspended on a water bath running at 60° C., and allowed to remain there for half an hour from the time the water in the bath rose again to 60° C. after its temporary fall consequent upon the introduction of the tubes. At the end of this time the tubes are removed from the water bath and suspended in a bath of running water to cool them down rapidly. Next 0·1 c.c. of emulsion is removed from each of several tubes, and surface plate cultivations established from each sample in order to demonstrate the absence of living cocci from the emulsion. The tubes of crude vaccine are then protected by indiarubber caps slipped over the cotton-wool plugs, and set aside in the ice chest until the result of the enumeration is known.

Having measured the bulk of the crude vaccine and determined the number of cocci present per cubic centimetre, a very simple calculation decides the amount of diluent to be added to the emulsion to reduce the number of cocci present per cubic centimetre to, say, 1000 millions, which is, perhaps, the most useful standard. The diluent employed is a 0·1-per-cent. saline solution, the necessary quantity of which is measured out into a large flask, and to it is added tricresol in such amount that the finished vaccine shall contain 0·25 per cent. of the disinfectant, tricresol being employed in preference to phenol or lysol on account of its lack of irritating properties.

The crude vaccine is now transferred by means of sterile pipettes

from the tubes in which the emulsion was sterilised to the flask containing the diluent and antiseptic, in which thorough mixture is effected. This flask is next connected up to the side feed of a graduated burette, and the vaccine filled into glass bulbs in quantities of 0·5 and 1 c.c. as required, the bulbs sealed off, in the blow-pipe flame, and labelled, with a writing diamond, with some distinguishing character or number, which indicates the character and number of cocci in suspension inside the bulb.

The Inoculations: Time.—The inoculation was usually performed the last thing at night (10 P.M.), so that several hours' rest in bed intervened before the heavy work of the following day commenced. In many instances, however, 11 A.M. or noon was the hour at which the injection was made, but so far as could be ascertained, the time at which the inoculations were carried out exercised no influence upon the immediate clinical results.

Site.—The site of inoculation was the subcutaneous tissue of the abdominal wall just below the costal margin. The skin in this situation was prepared by thoroughly cleansing a small area with a 2-per-cent. solution of lysol applied with cotton-wool, then removing all trace of the antiseptic by directing a stream of ether from a drop bottle on to the spot, or swabbing it well with a pad of wool saturated with ether. The ether served a subsidiary purpose, in that by its rapid evaporation it cooled the prepared area of skin and reduced its sensibility.

Dose.—The inoculations were made with the help of a hypodermic needle attached to a 10 or 20 c.c. syringe, holding 20 or 40 doses respectively, as the bulk of inoculum was invariably 0·5 c.c. By using a large syringe supplied with a number of spare hypodermic needles, it was only necessary to replace the soiled needle by a fresh sterile one, after each inoculation, and proceed to the next individual, thus saving much valuable time when many men had to be inoculated.

The vaccine brought from England for the purpose of these inoculations was numerically stronger than usual, and contained 2500 million cocci per cubic centimetre, so that the number of organisms per dose could readily be varied by suitable dilution of the emulsion.

The initial dose varied slightly in individual cases, but was either two, three, or four hundred millions of cocci. Subsequent doses were regulated by the response of the individual to inoculation, as judged by the movements of the curve representing the agglutinin-titre of the serum, but were usually 400 millions of cocci.

After the hypodermic injection of the vaccine, a wisp of cotton-wool and a drop of flexile collodion sealed the needle puncture and supplied all the dressing necessary.

In many of the cases two inoculations were given at suitable intervals.

Sequelæ of Inoculations.—Before giving the details of the inoculations carried out, and their results, a few words are necessary as to the local and constitutional effects following the introduction of the dead bodies of *M. melitensis* into the subcutaneous tissue of the normal human subject, as observed in these 51 men.

Local Appearances.—The introduction of such a small quantity of fluid into the subcutaneous tissue produced no immediate effect other than a slightly marked prominence of the skin at the seat of inoculation. Usually the emulsion was completely absorbed within a few hours, and on the morning following the inoculation no local alteration was discernable. In three of the orderlies of the R.A.M.C., the first inoculation was followed by a very distinct, hard, tender lump at the seat of inoculation, the skin over the swelling being red and slightly œdematous. Some tenderness of the inguinal and axillary glands was present so long as the lumps remained tender, but this passed off rapidly when the swelling had disappeared. In all three cases the swelling subsided without interference, the duration of a visible tumour being limited to two or three days respectively in the first two cases. In the third, the lump, which was on the right side, remained visible and tender for seven days, and was probably due to the fact that the subject —an ardent cricketer—was on bowling for practically the whole of the afternoon following inoculation. Several of the Sick Berth Staff of the Bighi Hospital complained of pain at the site of the needle puncture after the first injection, but in each case this was found to be due to the pull of the shrinking collodion on the surrounding fine hairs and not to any alteration in the tissues at the point where the emulsion of cocci was deposited. Inoculations subsequent to the first failed to cause any discomfort. The inguinal glands in many were slightly tender for the 24 hours following an injection, but not longer.

Constitutional Symptoms.—Beyond slight headache and feeling of malaise, associated with a rise of temperature to 98°·6 F. or 99° F., complained of by a few on the day following inoculation, no constitutional symptoms were observed. Two of the controls, however, who had been injected with normal saline solution complained of severe headache and showed temperatures of 99°·6 F. and 99°·8 F. respectively on the day following the injection. It will thus be seen that none of the disquieting results recorded by Lieut. Bousfield, R.A.M.C.,* were noted in this series of inoculations. That they do occur, however, was well shown in the case of one of the members of the Working Party who was inoculated by Lieut.-Colonel Leishman immediately prior to leaving England. Marked enlargement, accompanied by tenderness on pressure of the superficial lymphatic glands was observed within 24 hours of inoculation, together with some headache and malaise.

* Bousfield, L, "Some Remarks on Protective Inoculation against Malta Fever," 'Journ. R.A.M.C.,' vol. 7, 1905, pp. 179—182.

Table XXXVIII.—Results of Inoculation with *M. melitensis* Vaccine, Royal Naval Hospital, Bighi.

No.	Number of times vaccinated.	Serum value before inoculation.	1st inoculation.		2nd inoculation.		Serum value (28/8/06) 4 months later.
			Dose of vaccine.	Agglutinin response.	Dose of vaccine.	Agglutinin response.	
1	1	nil	200	1 : 100 +	—	—	1 : 10 +
2	2	,,	300	1 : 10 +	400	1 : 10 +	1 : 50 +
3	2	,,	300	1 : 50 +	400	1 : 50 +	1 : 100 +
4	2	,,	300	1 : 100 +	400	1 : 100 +	1 : 50 +
5	1	1 : 10 ±	200	1 : 100 +	—	—	nil
6	1	nil	200	1 : 100 +	—	—	1 : 5 +
7	2	,,	200	1 : 50	400	1 : 100 +	1 : 10 +
8	2	,,	200	nil	400	1 : 10 +	nil
9	2	,,	200	1 : 100 +	400	1 : 200 +	1 : 10 ±
10	2	,,	300	1 : 10 +	400	1 : 10 +	1 : 10 +
11	1	1 : 10 ±	200	1 : 200 +	—	—	1 : 10 +
12	2	nil	300	1 : 50 ±	400	1 : 10	1 : 25 +
13	2	1 : 10 ±	200	nil	400	nil	nil
14	2	nil	300	1 : 50 ±	400	1 : 10 +	1 : 5 ±
15	2	,,	200	1 : 100 +	200	1 : 100 +	1 : 50 +
16	2	,,	200	nil	400	1 : 100 +	1 : 5 +
17	2	,,	300	1 : 50 +	400	1 : 50	1 : 25 +
18	2	,,	300	1 : 10 +	400	1 : 10 +	1 : 10 +
19	1	,,	300	1 : 100 ±	—	—	1 : 25 +
20	1	,,	250	1 : 10 +	—	—	1 : 10 +
21	1	,,	250	1 : 10 +	—	—	1 : 10 +

Table XXXIX.—Results of Inoculation with *M. melitensis* Vaccine, Royal Military Hospital, Valletta.

No.	Number of times vaccinated.	Serum value before inoculation.	1st inoculation. Dose of vaccine.	1st inoculation. Agglutinin response.	2nd inoculation. Dose of vaccine.	2nd inoculation. Agglutinin response.	Serum value (28/8/06) 4 months later.
			millions.				
1	2	nil	200	nil	400	1 : 20 ±	nil
2	1	,,	400	1 : 100 +	—	—	—
3	2	,,	200	nil	400	1 : 10 +	1 : 10 ±
4	2	1 : 10 +	400	1 : 20 +	400	1 : 50 +	1 : 20 +
5	2	nil	400	1 : 20 +	400	1 : 20 +	1 : 10 +
6	1	,,	400	1 : 100 +	—	—	1 : 20 +
7	2	,,	200	nil	400	nil	nil
8	2	,,	200	nil	400	1 : 20 +	nil
9	2	1 : 10 +	200	1 : 20 +	400	1 : 20 +	1 : 50 +
10	1	nil	400	1 : 50 +	—	—	1 : 10 +
11	1	,,	400	1 : 50 +	—	—	1 : 10 +
12	1	,,	400	1 : 100 +	—	—	1 : 20 ±
13	2	,,	400	1 : 10 +	400	1 : 50 +	1 : 10 ±
14	1	,,	400	1 : 20 +	—	—	1 : 20 ±
15	2	,,	400	1 : 10 +	400	1 : 20 +	nil
16	1	,,	400	1 : 10 +	—	—	1 : 10 +
17	2	,,	400	1 : 20 ±	400	1 : 10 +	nil
18	1	,,	400	1 : 100 ±	—	—	nil
19	2	,,	400	1 : 10 +	400	1 : 100 ±	1 : 50 ±
20	2	,,	200	nil	400	1 : 20 +	nil
21	1	,,	400	1 : 50 +	—	—	1 : 20 +
22	1	,,	400	1 : 100 +	—	—	1 : 20 +
23	1	,,	400	1 : 50 +	—	—	1 : 20 ±
24	2	,,	200	1 : 10 ±	400	1 : 50 +	1 : 10 +
25	1	,,	400	1 : 10 +	—	—	1 : 10 +
26	2	,,	400	1 : 50 +	—	—	1 : 10 +
27	1	,,	400	1 : 20 ±	—	—	1 : 20 +
28	2	,,	200	1 : 20 +	400	1 : 50 ±	1 : 50 ±
29	1	,,	400	nil	—	—	nil
30	1	,,	400	1 : 20 +	—	—	1 : 20 ±

The seat of inoculation was occupied by a raised, hard, and tender lump, which gradually became soft and boggy to the touch, and the skin over it acquired a dusky-red colour. As there was every evidence of pointing, the tumour was incised on the 11th day and some thin serous pus, which proved sterile, was evacuated; and no higher dilution of the blood serum than 1 in 10 would give a positive agglutination reaction.

Later on an injection of the same brew of vaccine that was used in the series of prophylactic vaccinations now under consideration was introduced into the opposite flank. This was followed by a precisely similar train of events, although on this occasion the symptoms were distinctly less severe: the agglutination response on this occasion rose to 1 in 40.

Returning once more to the series of inoculations carried out upon men of the Naval Hospital and of the R.A.M.C. it must be noted that the response of the individual as judged by the movements of the agglutination value of the serum varied within wide limits from a positive reaction in a dilution of 1 in 200 to a negative reaction in a dilution of 1 in 5 as a result of the first injection.

A further point to be noted in the tabulated details is the very distinct fall in the titre of the serum that has taken place by the end of the four months, in one case from 1 in 200 to 1 in 10, showing that the individual response to vaccination, so far as relates to the production of antibodies of the agglutinin group at any rate, is limited to a comparatively short period, and apparently indicates that a further inoculation is necessary at the end of about three months after the first or second.

The immunity of the inoculated men during a period of four months from any attack of Malta Fever, though possibly due in part to the elimination of the "goat's-milk" factor, points to the necessity of a further trial of the *M. melitensis* vaccine—on a large scale; and in this case it would be of advantage to inoculate a large body of men, say half a regiment, before they enter the endemic area and then again after some three months' service in Malta.

VIII. Clinical Observations.

The limited time at the disposal of those members of the Working Party who were engaged in the Bacteriological and Experimental Investigation, no less than the paucity of cases occurring during the summer of 1906, precluded any extensive observations being carried out in connection with the clinical side of Malta Fever as it occurs in man. Certain points were, however, enquired into, and the results obtained are inserted here rather as indications of lines of research requiring further elucidation, than as dogmatic statements from which definite conclusions can be drawn.

Under these circumstances a bald outline of the observations made and the results obtained are all that are necessary, and these may be arranged under separate headings for convenience of reference.

(a) *Blood.—Presence of Micrococci therein.*—The presence and multiplication of *M. melitensis* in the blood of Malta Fever patients at various stages of the disease is now an established fact and fixes the position of the infection as a definite and specific septicæmia, though the researches of Gilmour and Shaw appear to indicate that the number of cocci present per cubic centimetre in the peripheral blood is usually small. A consideration of the work of these observers, however, led to the conclusion that if cases in the very early stages of the disease, at or near the summit of a period of pyrexia, were selected for observation and blood collected late in the day, relatively more organisms would be found than had hitherto been noted. A careful scrutiny of the case notifications enabled three cases to be eventually selected as especially suitable, and one observation was made on each patient.

The technique of the blood collection was that usually employed in hospital work in England; that is to say, the forearm was carefully washed, lathered with soft soap and shaved, then washed with lysol (2-per-cent. solution) and finally cleansed with ether, and a bandage was bound tightly about the arm above the bend of the elbow. The interior of a 5-c.c. all-glass syringe was next moistened with 10-per-cent. solution of sodium citrate in normal saline by first filling and then emptying the barrel; the object, of course, being to prevent any alteration in the physical condition of the collected blood, such as general or local clotting, between the moment of filling the syringe and of transferring the blood to the nutrient medium. The needle was then thrust into the lumen of either the median basilic or median cephalic vein and the syringe itself depressed and allowed to fill with blood as the piston was gradually withdrawn by gravity.

A series of test-tubes filled with accurately measured quantities of nutrient broth had previously been arranged in a test-tube rack. One cubic centimetre of the blood was then added to 9 c.c. of nutrient broth in the first test-tube and thoroughly mixed—this tube was labelled No. I. From Tube No. I, 0·1 c.c. of the mixed blood and broth was removed by a sterile graduated pipette and added to 9·9 c.c. broth in Tube No. II; 0·1 c.c. of the contents of Tube No. II were then added to 9·9 c.c. broth in Tube No. III. Next 1 c.c. of the contents of Tube No. I was added to a fresh tube of broth labelled Tube *1*: then 0·1 c.c. from Tube No. I was added to another tube of broth numbered Tube *2*. This process was then repeated with the two other tubes marked with Roman numerals, the Arabic figures *3*, *4*, *5*, and *6* being employed to distinguish the secondary tubes inoculated therefrom.

Thus a series of dilutions was obtained as under:—

		Cubic centimetres of blood.
Tube I	contained	1 (approximately)
,, *1*	,,	0·1
,, *2*	,,	0·01
,, *3*	,,	0·001
,, *4*	,,	0·0001
,, *5*	,,	0·00001
,, *6*	,,	0·000001

while Tubes Nos. II and III served as controls to Tubes *2* and *4* respectively.

Finally the 4 c.c. of blood remaining in the syringe were distributed amongst several tubes of broth to guard against the possibility of total failure to obtain a growth, which might otherwise happen if only a few cocci were present in the blood collected.

All the tubes were then incubated at 37° C. for preliminary enrichment, and on and after the third day plates were inseminated with broth from such of the tubes as showed naked eye growth.

Then by noting the tube containing the smallest quantity of blood from which the micro-organism was recovered it became an easy matter to calculate the number of cocci present per cubic centimetre in the peripheral blood of the patient.

By following this procedure the coccus was found to be present in all three cases in fairly large numbers. The following are the details of these cases :—

1. Private Kirton—onset of disease, 18.6.06 : admitted to hospital, 21.6.06. Blood collected, 25.6.06 at 7 P.M. Serum agglutination value—1 in 2000. *M. melitensis* present to the number of at least 1900 per cubic centimetre.
2. Private Fitzgibbon—onset of disease, 28.5.06 : admitted, 31.5.06. Blood collected, 5.7.06 at 7 P.M. Serum value—1 in 200. *M. melitensis* present to the number of 10,000 (but not 100,000) per cubic centimetre.
3. Private Kearney—onset of disease, 20.5.06 : admitted, 23.5.06. Blood collected, 5.7.06, at 7.30 P.M. Serum value—1 in 200. *M. melitensis* present to the number of 1000 (but not 10,000) per cubic centimetre.

2. *Leucocyte Formula.*—The work of the French observers in Tunis—Hayat, Cathoire, Cardaliguet, Schoull, etc.—tends to show that the leucocyte formula of the blood in Malta Fever cases presents a consistent variation from the normal, and to this variation is attached diagnostic importance. The variation is stated to be in the direction of a relative and often an absolute increase in non-granular cells ; and the few

Table XI.—Blood Counts in Malta Fever.

Name.	Date of admission.	Type of case.	Date of blood examination.	Serum value.	Red cells per cubic millimetre.	Hæmoglobin.	Cell index.	White cells per cubic millimetre.	Differential count of white cells per centum.							
									Small lymphocytes.	Large lymphocytes.	Large hyaline mononuclear cells.	Polymorphonuclear neutrophiles.	Eosinophiles.	Mast cells.	Total non-granular cells.	Total granular cells.
						p.c.										
Serg.-Maj. A.	30/6/06	Mild	27/7/06	1 : 500,000	4,870,000	90	0·92	7600	47·6	3·6	3·4	45·0	0·0	0·4	54·6	45·4
Staff-Serg. B.	2/6/06	Severe	26/7/06	1 : 50	5,100,000	59	0·57	9000	19·8	2·4	5·0	70·0	2·2	0·6	27·2	72·8
Pte. K.	2/6/06	Severe	26/7/06	1 : 2,000	4,670,000	68	0·72	7000	44·2	3·6	1·2	48·0	3·0	0·0	49·0	51·0
Rifleman J.	11/7/06	Mild	26/7/06	1 : 20	4,970,000	79	0·79	7000	42·8	3·6	2·0	50·2	0·6	0·8	48·4	51·6
Normals			—	Nil	5,000,000	100	1·00	7500	24		5·0	70·0	0·5—1	?	29·0	71·0

observations made during the summer on this point afford some confirmation of these statements.

In four cases a complete blood examination was carried out, the red and white cells being enumerated by the aid of the Thoma Zeiss hæmatocytometer, the hæmoglobin estimated in a Gower's hæmoglobinometer, and a differential leucocyte count, made on films, stained by Jenner's method—the classification adopted under the last heading being that advocated by Price-Jones,* to whom we are greatly indebted for confirming the accuracy of the counts. The results obtained are tabulated in Table XL, from which it will be seen that in three there was a very marked rise in the non-granular cell-content of the blood. In the fourth the deviation from normal was only noticeable in the deficiency of hæmoglobin.

(b) *Milk.*—Although, arguing from analogy, it was a foregone conclusion that *M. melitensis* would be found in human milk, actual demonstration had hitherto been wanting on account of the infrequency of lactation being associated with Malta Fever. During the summer of 1906 opportunity was afforded of investigating three cases only, but from two of these the micrococcus was recovered.

In collecting specimens of the milk, the breast was first washed up with soap and water, then with ether, then the bell opening of a sterile glass breast pump was applied and the milk received in the side bulb. Details of the successful recoveries are as follows:—

Mrs. A., Military Family Hospital, Valletta. Onset of disease, 7.5.06. Date of delivery, 24.6.06. The flow of milk was scanty from the first and the mother was unable to suckle her infant, which was consequently hand-fed on condensed milk. A sample of milk was collected from the right breast 26.6.06. The milk, which was yellowish in colour and distinctly oily, gave a complete agglutination reaction in dilution of 1 in 100. Single drops (about 0·03 c.c.) were used to inseminate each of about a dozen plates, which after incubation yielded about half-a-dozen colonies of *M. melitensis* per plate, so that each cubic centimetre of milk contained about a couple of hundred micrococci. A second sample of milk collected 5.7.06, required the exercise of powerful suction before even a couple of cubic centimetres could be obtained. The agglutination reaction was now obtainable in dilution of 1 in 2000, and *M. melitensis* was present to the number of some 300 per cubic centimetre.

C. G., Misida. Attack of Malta Fever, September—December, 1904, during the puerperium. The milk practically dried up and the child was hand-fed. Eighteen months later (June, 1906) patient

* Jones, C. Price, 'Brit. Med. Journ.,' 1905, vol. 1, pp. 409, 410; 1905, vol. 2, pp. 1112, 1113.

Table XLI.—*M. melitensis* in Urine of Ambulatory Cases.

Date of plating.	1857. B. Worley.		3414. F. Mallia.	
	Treatment.	Number of colonies of *M. melitensis* per c.c.	Treatment.	Number of colonies of *M. melitensis* per c.c.
April 20	nil	440	Daily from 27/4/06 to 1/6/06 peroxide of succinic acid 2 grs. p. aq. dist. ad. 3 x.	9,000
,, 24	,,	1,800		2,000
,, 27	,,	720		12,000
May 1	,,	3,000		21,000
,, 4	,,	185		300
,, 8	,,	2,350		10,500
,, 11	,,	1,800		12,000
,, 15	,,	1,000		∞
,, 18	,,	1,060		600
,, 22	,,	860		600
,, 25	,,	1,900		950
,, 29	,,	∞		1,500
June 1	,,	∞		∞
		on leave		
,, 12	,,	40	nil	nil
,, 15	,,	2,140	,,	,,
,, 19	,,	180	,,	,,
,, 22	,,	10	,,	,,
,, 26	,,	150	,,	,,
,, 29	,,	240	,,	,,
July 3	,,	1,068	,,	,,
,, 6	,,	3,890	,,	,,
,, 20	,,	110	,,	,,
,, 24	,,	2,555	,,	,,
,, 27	,,	1,020	,,	,,
,, 31	,,	2,210	,,	,,
Aug. 1—14	Daily from 18/8/06 to 31/8/06 peroxide of succinic acid, as Mallia	not enumerated, but *M. melitensis* constantly present	nil	nil
,, 21 ...		500	,,	,,
,, 24 ...		1,242	,,	,,
,, 28 ...		28	,,	,,
,, 31 ...		301	,,	,,
Sept. 4	nil	705	,,	,,
,, 7	,,	6,300	,,	,,
,, 11	,,	24,140	,,	no sample
,, 14	,,	14,000	,,	nil
,, 18	,,	3,500	,,	,,
,, 21	,,	2,650	,,	,,
,, 25	,,	6,715	,,	,,
,, 28	,,	7,600	,,	,,

∞ = innumerable.

states that flow of milk has never entirely ceased—small quantities can still be squeezed from the gland. A sample of a couple of cubic centimetres collected in the sterile breast pump by the aid of a combination of suction and expression on three several occasions. The milk, which appeared normal in colour and consistence, gave a positive reaction in dilution of 1 in 200. Plate cultivations to the number of three were prepared, each with 0·5 c.c. of the milk at each examination. At the first and third *M. melitensis* could not be detected in the resulting growth, but at the second examination saprophytes were practically absent, and colonies of *M. melitensis* to the average number of 25 were present in each of the three plates, *i.e.*, average 50 per cubic centimetre.

(c) *Urine.*—The two cases of Ambulatory Malta Fever in workmen in R.N. Dockyard handed over by Staff-Surgeon Shaw, R.N., when he left Malta,* were kept under observation during the summer.

No. 3414, F. Mallia, was treated from 24.4.06 to 1.6.06 with peroxide of succinic acid in the form of a 1 in 10,000 solution, 5 ounces of the solution being administered morning and evening, and by June 15 the *M. melitensis* had disappeared from the urine.

No. 1857, B. Worley, who served as a control to the previous case whilst peroxide was being administered, continued to pass urine containing large numbers of *M. melitensis* until October, when the examination of his urine was discontinued, although he, too, had been put on the peroxide in similar doses for a fortnight from 18.8.06 to 31.8.06.

(d) *Fæces.*—Only one or two observations were made with a view to the detection of *M. melitensis* in the fæces. The results so far as concerned firm, formed motions, were negative, but in one fatal case (Private R.) of one and a-half months' duration, where the intestines were filled with light semi-fluid fæces, the presence of *M. melitensis* in considerable numbers was demonstrated after plating on ox serum nutrose agar.†

(e) *Post-mortem Examinations.*—But two fatal cases of Malta Fever occurred during the first eight months of 1906 in the R.M. Hospital, Valletta, upon which *post-mortem* examinations were held. The details of these are here tabulated.

Several *post mortems* (which were witnessed by the courtesy of the staff of the Civil Hospital) were conducted on fatal cases of Malta Fever, but in these systematic bacteriological investigations were not carried out.

* See these Reports, IV, p. 12 and V, p. 40.

† Eyre, J. W. H., "The Preparation of Nutrose Agar," 'Trans. Path. Soc.,' vol. 55, 1904, pp. 91--105.

Table XLII.—*Post-mortem* Details.

Organ or tissue examined.	Pte. D. 27/1/06.	Pte. E. 31/5/06.
Heart blood	*M. melitensis* present	*M. melitensis* present
Pericardial fluid	not examined	"
Spleen	*M. melitensis* present	"
Bile	not examined	"
Inguinal glands	"	"
Mediastinal glands	"	absent
Mesenteric glands	*M. melitensis* present	*M. melitensis* present
Salivary glands	"	not examined
Thyroid glands	"	"
Suprarenal glands	"	"
Pancreas	"	"
Fæces	not examined	*M. melitensis* present

IX. *Conclusions.*

It must be noted that, in addition to breaking new ground, much of the experimental work of the Mediterranean Fever Commission during the summer of 1906 has necessarily been arranged in order to elucidate the previous work of individual members and to collate the recorded facts; and from a general review of the whole question of *M. melitensis* infection in man, and in the light of our present knowledge, it may be fairly stated that—

(*a*) The most common method of infection is by the ingestion of infective articles of food—mainly milk.

(*b*) The next common path of infection is by subcutaneous inoculation during the handling of infective material—usually milk.

(*c*) More rarely infection may occur as the result of contagion, or, possibly, through convection by means of blood-sucking insects.

The results obtained by the Working Party during the summer of 1906 have been summarised in the foregoing pages in connection with the headings to which they relate; the more obvious and the more important of the conclusions arrived at are here recapitulated :—

1. The goat is highly susceptible to infection by *M. melitensis* as the result of cutaneous, subcutaneous, intravenous, and intraperitoneal inoculation, and as the result of feeding with infective material.

2. The course of the resulting septicæmia is extremely mild, and usually after the first few days cannot be demonstrated by clinical observation.

3. In order to detect *all* the infected milch goats in any given herd it is necessary to repeatedly examine the milk at short intervals. In selecting milks for bacteriological examination a positive milk agglutination reaction (Zammit's test) is a much more reliable indication

of the presence of *M. melitensis* than is a positive serum agglutination test.

4. During the course of the infection the *M. melitensis* first disappears from the peripheral blood and from most of the viscera, next from the spleen and kidneys, next from the superficial lymphatic glands, and last of all from the mammary gland.

5. The appearance of *M. melitensis* in the milk of the goat is a comparatively late phenomenon; the coccus present in this fluid is fully virulent, and the milk itself highly infective. The number of *M. melitensis* in the milk varies within wide limits from day to day, and bears no relationship to the severity of the infection, air temperature, etc.; the presence of *M. melitensis* in the milk appears to be merely the result of a mechanical flushing of the mammary gland by means of which the cocci multiplying therein are removed.

6. *M. melitensis* is not destroyed during the processes incident upon the manufacture of the ordinary ice-creams, or of the native cheeses, and may be present in the retail articles living and unaltered in virulence.

7. The association of infected milch goats in a herd with cases of Malta Fever in the owner's family (the members of which do not as a rule partake of the milk) suggests the frequency of cutaneous inoculation through scratches and abrasions of the human skin.

8. The administration by the mouth of infective goats' milk is usually followed in the monkey by an attack of *M. melitensis* septicæmia, 83 per cent. of the experimental animals yielding absolute and conclusive evidence *post mortem* of the existence of *M. melitensis* septicæmia, irrespective of the dose of infective bacteria.

9. The eight members of the crew of the "Joshua Nicholson," and one woman in the United States developed Malta Fever after the ingestion of infected milk under conditions which point to the absence of other sources of infection.

10. Weak solutions of hydrochloric acid exert some slight bactericidal power on *M. melitensis in vitro*, which becomes more marked when pepsin is also present in the solution. The introduction of infective milk directly into the stomach was not, in the two experiments made, followed by *M. melitensis* infection.

11. The mosquito (Acartomyia and Stegomyia) and the common blood-sucking fly (Stomoxys) can act as the host of *M. melitensis* for a short period, generally limited to four or five days, and during that time the bacterium retains its virulence unimpaired.

12. *M. melitensis* can exist for many days in, and be recovered in a virulent condition from, the "droppings" of these insects.

13. One only out of a number of experimental animals (in 14 of which exact data are available) showed signs *post mortem* of a mild

infection by *M. melitensis*, subsequently to being bitten by highly infective mosquitoes.

14. The existence of *M. melitensis* in urine and vaginal swabbings of infected females, together with the successful inoculation of experimental monkeys through the mucous membrane of the glans penis, points to the possibility of infection in man during sexual congress.

15. The inoculation of *M. melitensis* vaccine in the normal man is but rarely followed by any marked local or constitutional disturbance.

16. The prophylactic use of one or two doses of such vaccine in some 60 cases appears to have afforded protection for a period of about four months, and suggests the necessity of repeating this observation on a large scale—the first treatment to be carried out prior to the entrance of the men into the endemic area.

17. The therapeutic use of *M. melitensis* vaccine appears likely to become a valuable method in the treatment of the infected milch goats.

18. The few clinical observations that were made by the Bacteriological Section of the Working Party :—

(1) Demonstrated the presence of *M. melitensis* in human milk and fæces.

(2) Indicated the necessity for further investigation into the "leucocyte formula" in blood of Malta Fever cases in view of possible variations therein affording useful aid in diagnosis; and also for further investigation into the phenomenon of the passage of *M. melitensis* in the urine with a view to the selection of one or more urinary germicides capable of destroying the cocci in the genito-urinary tract.

Recommendations as to Preventive Measures in Connection with Mediterranean Fever in Malta.

Various suggestions for the prosecution of a campaign against Mediterranean Fever arise from a consideration of the bacteriological and experimental data detailed in the Report of the work of the Mediterranean Fever Commission during 1906.

These fall naturally into one of two broad groups which, for our present convenience, may be designated by the titles of "palliation" and "eradication" respectively, and deal with the measures which must necessarily be adopted according to whether we merely wish to relieve our Navy and Army of the disastrous effects inseparable from the incidence of the disease, or to attempt the stamping out of Malta Fever from a dependency of the Crown which has, in the past, been considered of some strategic importance.

The first point to which attention should be directed, no matter what preventive measures are ultimately instituted, is the provision of an efficient and thorough system of compulsory notification of Mediterranean Fever. The system should probably be introduced in the form of an "Ordinance," and modelled on the lines of that at present in force in the British Isles under the Infectious Diseases (Notification) Act, 1889, and should be organised from a Central Office to which all notifications—naval and military as well as civil—should be sent. Provision should be made for the payment through the Public Health Department of fees (which in this instance need not exceed 6*d.* per notification) to civil practitioners in attendance on cases of Mediterranean Fever, and, on the other hand, for penalties for such as wilfully disregard the enactments of the Ordinance.

Palliation.—Reviewing the evidence already collected by the Mediterranean Fever Commission in its entirety, it is fairly obvious that the infective character of the milk of many of the goats upon the island of Malta affords a ready and reasonable explanation of the means by which the disease is transmitted. Then, too, the evidence yielded by experiments upon monkeys, supported by the facts of the s.s. "Joshua Nicholson" epidemic, justifies the assumption that in the ingestion of infected milk we have the veritable infective agency in the vast majority of cases. Additional weight attaches to this view by reason of the declining case incidence that was associated with the compulsory substitution (owing to the goatherds' strike) of imported preserved milks for the fresh goats' milk by the local naval and military authorities. Consequently, the strict prohibition of the use of the local supplies of fresh milk by the garrison and fleet should result in a very large diminution of the wastage from Malta Fever, and is a preliminary measure which must be enforced

during the period that will necessarily elapse before the existing supply of virus is appreciably influenced by the measures to be suggested with a view to the eradication of the disease. Whether or no the time is yet ripe for the State supervision of the milk supplies, the erection of depôts, constructed upon sanitary principles, for the milking of goats and other animals, and the subsequent distribution of the milk, is an open question; but in any case the liberty of the goat to perambulate the streets of Valletta and other large towns, to feed from the garbage of the gutter, and to pollute the atmosphere, must be curtailed to the extent of prohibiting the entry of the animals into the fortified cities and barrack squares, if only to increase the effectiveness of regulations based upon the above recommendations.

Eradication.—The measures to be adopted under the preceding heading are comparatively simple, and when dealing with a disciplined body of men, such as compose our Navy and Army, fairly easily enforced. Measures for the stamping out of the disease, on the other hand, which have to be applied to the goat and other milk-yielding animals through the intermediary of the owner, must needs bring the sanitary authorities into conflict with the usually uneducated and often violently prejudiced native of the agricultural class, and it is uncertain how far recommendations under this head will, from the diplomatic point of view, commend themselves to the civil authorities. In the event of any or all such recommendations being adopted, the Ordinance upon which they are based will need to be administered with great firmness and tact.

In the first place, it is essential that all the goats in the island should be registered, and some method should be employed of numbering by means of stamped metal discs (such as is already carried out in the case of dogs), which will afford a ready means of identification of individual animals. Next, repeated analyses of samples of milk, taken at regular intervals, must be made in respect to every milch goat by medical officers of health (who need not be bacteriological experts) specially detailed for this purpose, at three, four, or more district "centres," where laboratories for the application of the Zammit milk test must be provided. Further, samples of the milk from each animal, giving a positive reaction with this test, must then be sent to the Central Laboratory in the Public Health Department at Valletta for bacteriological examination for the demonstration of the presence of *M. melitensis*. So far the suggested measures are simple in theory, and by no means costly in practice; nevertheless, unless carefully handled, the Maltese goatherd will offer considerable opposition to their execution.

The remaining measures deal with the segregation of such infected animals as are found from time to time to be yielding milk containing

the specific micro-organism of Mediterranean Fever, and will necessarily be more expensive in operation, though, considering the importance of the issue at stake, not unduly so.

The total number of goats to be dealt with amounts approximately to 20,000, of which probably at least 2000 are infective, so that provision should be made on a liberal basis for dealing with possibly 5000 animals during the first year's work. When an animal is definitely shown to be yielding infective milk, it should be at once seized by the sanitary authorities and transferred to the Lazzaretto, or some other "pound" to be subsequently established, the owner being compensated on a scale comparable to that employed in Great Britain when infective animals (*e.g.*, in pleuro-pneumonia, tuberculosis, etc.) are seized by the public health authorities, and the milk stall should be disinfected and lime-washed. As, however, the flesh of infected goats, etc., is harmless when cooked, considerably more than half of the animals thus seized could be slaughtered, the viscera destroyed, and the flesh sold for consumption—a proceeding which would materially lighten the cost of these preventive measures. Moreover, as the progeny of infected milch goats is itself uninfected at birth, the seizure and destruction of infected animals should be combined in the case of the more valuable animals—the specially good milkers, etc.—with a modification of the "Bang process" for the reproduction of tuberculous herds, under the direct control of the Public Health Department, at special breeding farms where the selective in-breeding, which has rendered the Maltese milch goat such a valuable animal, could be continued under skilled supervision. This process, devised by Professor Bang, of the Copenhagen Veterinary College, as applied to tuberculous herds, has already been carried out with marked success in Denmark, Hungary, and the United States of America, and it appears probable that in dealing with the *M. melitensis* infection in goat the whole of the infective animals thus seized would be the replaced by healthy animals in the course of three or four years. Here, again, by the sale of yearlings a considerable return might be effected. While the capital sum required to organise and carry out all these measures in an efficient manner is greater than the civil authorities in Malta could readily devote to the purpose, the enormous saving in fighting material that would accrue to the Navy, and particularly to the Army, by the disappearance of Mediterranean Fever from the Maltese Islands, would amply justify an appeal to the Imperial Exchequer—assuming, of course, that Malta retains its present importance as a base for our sea and land forces.

Although, as is indicated later, certain powers are available already under Ordinance III of 1904, it would probably be preferable to introduce a new Ordinance for the purpose of stamping out Mediterranean Fever from the goats of the Maltese Islands, under the title of Infectious Diseases (Mediterranean Fever) Ordinance of 1907.

The various suggestions embodied in the foregoing paragraphs are here summarised.

Regulations for the Prevention of Mediterranean Fever.

I. *General.*

1. Compulsory notification enforced under an Ordinance which provides fees for compliance with, and penalties for disregard of, its provisions.
2. Popular education with regard to disinfection of excreta of patients suffering from Mediterranean Fever.
3. Prohibition, by Ordinance, of exportation (or importation) of goats, cows, ewes, asses, or other animals yielding milk for domestic purposes, which are the subjects of *M. melitensis* infection.
4. Prohibition of the entry of goats into Valletta and fortified cities, and into barrack squares, etc.

II. *Palliation.*

1. Popular education with regard to the infective character of the milk from certain animals with instructions as to boiling the fluid to destroy its noxious character; also with regard to the infective nature of milk products from such animals (*e.g.*, cheese, ice-cream).
2. Absolute prohibition, by orders from the Admiral commanding the Mediterranean Fleet and the officer commanding the land forces, of the purchase and consumption of native fresh milk (or of milk products, such as cheese, ice-cream, etc., prepared from native milk) by either officers or men, provision being made for definite penalties in the event of disobedience.
3. The official supply, by importation, of a sufficiency of reliable brands of preserved and condensed milks to the naval, military, and civil hospitals, and to the various canteens and messes.

III. *Eradication.*

1. Compulsory registration (by Ordinance) of every owner of one or more goats, cows, ewes, milch asses, etc., whether kept for the purpose of trade or otherwise, and of every breeder of such animals, and the granting of a metal badge bearing a specific sign or number for each animal, such badge to be securely attached to the animal to which it has been assigned, provision being made for the imposition of penalties for disregard or evasion of the enactments of this Ordinance.
2. Strict enforcement of Ordinance No. III of 1904, Cap. II, Section 5, Articles 79, 82, 83, and of the penalties referred to in Cap. IV, Articles 161 165, 174 (by Ordinance).

3. The interpolation of the words "milch goat, milch ass, ewe, or other animal yielding milk for domestic purposes" after the words "milch cow," in every article of the Fifth Section of Ordinance No. III of 1904, where such words are needed to apply the provisions of the article to animals other than the milch cow; also the interpolation of "Mediterranean Fever" into Article 91 (*b*), specifying certain infective diseases of animals; also the interpolation of the words "Mediterranean Fever" after the words "tuberculous disease" in Article 93, specifying powers of entry by sanitary officials, and of the words "or ice-creams" into Article 100 (2), specifying milk products to which the article is applicable.

4. The establishment of small laboratories with an adjoining compound, equipped for the performance of the "Zammit" milk test and the segregation of infected animals in such districts as Zeitun, Zurrik, Gargur, Notabile, and Mellieha in Malta and Victoria in Gozo, each under the charge of a specially detailed medical officer of health, assisted by a sanitary inspector; the function of each district laboratory being to examine once in every two weeks a sample of milk from each milch goat, etc., within its district; to seize, to segregate, and to report to the Public Health Department such animals as yield a positive reaction, and to forward specimens of their milk for bacteriological examination, and on the removal of infected animals to supervise the disinfection, etc., of the premises from which the seizure has been made.

5. On completion of proof that suspected animals are infected and infective, the Public Health Department shall seize such animals and dispose of them, either by slaughter and sale in the public abattoir, or otherwise, and compensate the owner according to a fixed scale to be subsequently determined.

6. In the case of valuable animals, good milkers and in good condition, the owner shall be compensated as in 5, and the animals retained alive for breeding purposes at an experimental station situated, say, at Ghain Tuffieha.

7. Immediately after the birth the offspring of infected dams shall be removed and subsequently fed on milk from healthy animals or on Pasteurised milk from infected animals.

8. As the infected animals are replaced by healthy ones they may be fattened up, slaughtered at the public abattoir, and the flesh sold.

9. Finally, experimental treatment by *M. melitensis* vaccine, on the lines indicated in this Report, should be carried out on a large scale, and its potentialities estimated.

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ST. MARTIN'S LANE.

REPORTS

OF THE

COMMISSION

APPOINTED BY

THE ADMIRALTY, THE WAR OFFICE, AND
THE CIVIL GOVERNMENT OF MALTA,

FOR THE INVESTIGATION OF

MEDITERRANEAN FEVER,

UNDER THE SUPERVISION OF AN

ADVISORY COMMITTEE

OF

THE ROYAL SOCIETY.

PART VII.

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
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APRIL, 1907.

INTRODUCTION.

In the introductions to Parts I and III the history of this investigation was related from its commencement in June, 1904, until July, 1905.

The Commission appointed to continue the work during the summer of 1905 consisted of Lieut.-Colonel A. M. Davies, R.A.M.C., Major W. H. Horrocks, R.A.M.C., Staff-Surgeon E. A. Shaw, R.N., Dr. T. Zammit, Board of Health, Malta, and Captain J. Crawford Kennedy, R.A.M.C.

Lieut.-Colonel Davies left Malta for England on September 24, and Major Horrocks for Gibraltar on October 14, 1905, while Messrs. Shaw, Zammit, and Kennedy continued the investigation during the following winter. The results of the work of the Commission during 1905 are published in Parts III, IV, and V.

At a meeting of the Mediterranean Fever Sub-Committee held on February 25, 1906, it was decided to continue the work during the ensuing summer, and, as Messrs. Davies, Horrocks, and Shaw would not be available, that Major T. McCulloch, R.A.M.C., Major J. C. Weir, R.A.M.C., Major J. G. McNaught, R.A.M.C., Staff-Surgeon F. H. A. Clayton, R.N., and Dr. J. W. H. Eyre, M.D., Bacteriologist to Guy's Hospital, be appointed to the Commission in addition to Captain Kennedy and Dr. Zammit.

Colonel D. Bruce, R.A.M.C., Chairman of the Sub-Committee, was also requested to proceed to Malta to introduce the new members to the work. He arrived in Malta on April 14, 1906, and work was at once begun on the lines laid down by the Sub-Committee in their memorandum dated February 23, 1906. He left for England on May 5.

Dr. Eyre and Major McNaught remained in Malta until September 2, and Staff-Surgeon Clayton, Majors McCulloch and Weir, and Captain Kennedy until the end of that month.

The work done in the summer of 1906 is embodied in Parts V, VI, and VII:—

Part VI.—"Report upon the Bacteriological and Experimental Investigations during the Summer of 1906," by J. W. H. Eyre, M.D., Major J. G. McNaught, R.A.M.C., Captain J. C. Kennedy, R.A.M.C., and Dr. T. Zammit.

Part VII.—"Epidemiological Work in 1906: (*a*) Naval," by Staff-Surgeon F. H. A. Clayton, R.N.; "(*b*) Military and Civil," by Majors T. McCulloch and J. C. Weir, R.A.M.C.

The Bacteriological Report (Part VI) discusses infection by goats' milk, conveyance by mosquitoes and other blood-sucking insects, infection by contact, prophylactic vaccination, and clinical observations. Dr. Eyre and his colleagues sum up their results by saying that the ingestion of infective articles of food, mainly milk, is the most common path of infection by *Micrococcus melitensis* in man; that the next common path of infection is by subcutaneous inoculation during the handling of infective material, usually milk, and that more rarely infection may occur as the result of contagion, or possibly through convection by means of blood-sucking insects.

The Epidemiological Reports (Part VII) go fully into the occurrence of cases of Mediterranean Fever in ships, barracks, and hospitals, with statistics relating to the incidence among various classes, effect of age and sex, residence, climatic conditions, etc., and also give a detailed account of the result of preventive measures instituted in the middle of 1906.

The epidemiologists are led to believe that quite 70 per cent. of the cases are due to the ingestion of goats' milk. They also believe that it is probable that the disease is acquired through infected milk, or, less often, urine, coming in contact with breaches of the surface, and so inoculating the disease. In their opinion, ordinary contact with the sick, conveyance of infection by biting insects, house-flies, dust, drain emanations, food (other than milk), and water play a very subordinate part, if any, in setting up Mediterranean Fever in man.

The excellent results following the preventive measures directed against the use of goats' milk in barracks and hospitals also point to milk being the chief factor.

Among the soldiers this resulted in a diminution of about 90 per cent. For example, in the second half of 1905 there were 363 cases of Mediterranean Fever, whereas in the corresponding part of 1906 there were only 35 cases. Among the sailors there was also as marked a fall in the number of cases. Very remarkable is the history given by Staff-Surgeon Clayton in regard to the Naval Hospital at Malta. This building had a bad reputation, as one-third of the cases of fever occurring in the fleet at Malta could be traced to residence in this hospital, either as patients suffering from other diseases or among the nursing staff. The goats supplying the hospital with milk were examined, and some 10 per cent. of them were found to be passing *Micrococcus melitensis* in their milk. About the end of June goats' milk was forbidden, and since then not a single case of Mediterranean Fever has occurred in, or been traced to residence in, this hospital.

Taking all the facts and arguments into consideration, it would appear that this Commission has been successful in discovering the main source of infection of Mediterranean Fever. This source is the Maltese goats, some 20,000 in number, half of which are affected by

Mediterranean Fever, and one-tenth are constantly passing the parasite of this disease in their milk. If this source of infection is removed, in all probability the fever will disappear completely from Malta.

The special thanks of the Commission are due to His Excellency the Governor; the Lieutenant-Governor; Lord C. Beresford, Naval Commander-in-Chief; Colonel Winter, A.S.C.; Colonel J. G. MacNeece, R.A.M.C., P.M.O., Malta; Lieut.-Colonel J. H. Rhodes, R.A.M.C.; Lieut.-Colonel R. Jennings, R.A.M.C.; Major G. S. Crawford, R.A.M.C.; and Captain E. Ryan, R.A.M.C.; and the officers of the Royal Army Medical Corps generally; Deputy-Inspector-General Bentham, R.N., and officers, Bighi; the Hon. L. Gatt, C.M.G.; the Hon. Sir R. Micallef, K.C.M.G., the Governor, Detention Barracks; Mr. A. M. MacFarlane, Government Veterinary Surgeon; Professor Samut and Dr. Portelli Carbone, of the Civil Hospital; Dr. Caruana Scicluna, and Dr. A. Critien, Board of Health; Drs. Said and Rutter, of the Government Medical Service; Mr. T. Curmi, Superintendent of Police; the Superintendent of the Civil Hospital; Mr. Grout, of the American Consular Service; Fleet-Surgeon Hardie, of H.M. Dockyard; Professor Magro and Cyril Leach, Esq., of the Meteorological Department, University of Malta.

EPIDEMIOLOGICAL WORK IN 1906.

By Major T. McCulloch, M.B., Major J. C. Weir, M.B., Royal Army Medical Corps, and Staff Surgeon F. H. A. Clayton, M.D., Royal Navy.

(Received 25th January, 1907.)

Introductory.

As the result of a recommendation of the Sub-Committee of the Royal Society, one naval and two army medical officers were appointed to the Commission in 1906, to continue the investigation of the causation of Mediterranean Fever from the epidemiological side. Accordingly, the writers of this part of the Report arrived in Malta in April and worked there until October, a period which covers the season when the disease is most prevalent.

Epidemiological work on behalf of the Commission was begun by Dr. R. W. Johnstone, of the Local Government Board, in the fever season of 1904, and it was continued by Lieut.-Colonel A. M. Davies, R.A.M.C., in the following year. Dr. Johnstone's Report gives such topographical details as are of importance in an epidemiological enquiry, together with a general sanitary survey of the Maltese islands, and he deals comprehensively with the prevalence of Mediterranean Fever among the civil, naval, and military sections of the population. Lieut.-Colonel Davies devoted most of his time to a critical study of the disease as it manifested itself amongst the troops and the military families constituting the garrison in 1905, and he also furnished a detailed report on the sanitary condition of the various barracks in which the troops are housed and of the hospitals in which their sick are treated. The ground was, therefore, cleared to a large extent by the work of both of those observers, and this Report should be read in conjunction with theirs, as there would be no object in repeating information concerning which there is nothing new to record. Some overlapping will, however, be unavoidable, as, for example, in bringing tables or other matter up to date.

No limit was placed on the scope of the epidemiological work to be undertaken during the season of 1906, but we were aware that the Sub-Committee considered the following points as of special importance:—

1. The early and careful study of each case of Mediterranean Fever, and its surroundings.

2. The possibility of the conveyance of the disease to man by the use of goats' milk or its products.
3. Mosquitoes, flies, or other insects as possible carriers of the disease germs.
4. Facts bearing on the determination of the incubation period.

As our work proceeded, other points came to the front, *e.g.*, the question of place infection, the relation of simple continued and enteric fevers, the insidious nature of the onset of illness, etc. It early became evident that some attention to an analytical study of the statistical history of past years was essential, and that important information was to be obtained from comparison of the behaviour of the disease in other stations. Further, in our capacity of service medical officers, we were instructed to act in concert with the naval and military authorities regarding practical measures, such as the provision of isolation accommodation for military cases, and in recommending the application of any additional preventive measures in relation to both army and navy, or the modification of any of those already in use, which the course of investigation might suggest. In addition to the investigations relating to the services, steps were taken for keeping up the observations, commenced by Dr. Johnstone in 1904, as to the prevalence of the disease amongst the civil population.

This Report will, therefore, be divided into the following parts:—I, Naval; II, Military; III, Civil. Following Part III is a paper, contributed by Dr. A. Critien, of the Public Health Department, Malta, on goats' milk as a factor in the causation of Mediterranean Fever amongst the civil population. Finally, a general summary has been drawn up, in which are given the conclusions drawn from a critical examination of the naval, military, and civil observations.

Division I.—NAVAL.

By Staff-Surgeon F. H. A. Clayton, M.D., Royal Navy.

SYNOPSIS OF CONTENTS.

Section A.—Epidemiology of Mediterranean Fever in the Navy.

SECTION B.—PREVENTIVE MEASURES INSTITUTED AGAINST MEDITERRANEAN FEVER IN THE NAVY.

SECTION C.—PERSONAL INVESTIGATIONS.

The epidemiological work which has been undertaken this year may be divided into three sections: (A) Historical; (B) Preventive measures and the incidence of the disease since their institution; and (C) Personal investigations, including a study of the disease as it has occurred in separate ships, and of the facts elicited from enquiry into individual cases.

Section A.—EPIDEMIOLOGY OF MEDITERRANEAN FEVER IN THE NAVY.

In connection with the epidemiological section it was felt that where, as in sea-going ships, the environmental conditions were so perpetually varying, any attempt to study the history of the disease as it has occurred in separate ships would not repay the expenditure of time. Presence in or absence from Malta, the time of year, position in the harbour, and so on, are all factors that have to be reckoned with, and about which it is impossible to obtain accurate information.

Accordingly, attention has been concentrated upon the connection of Mediterranean Fever with conditions which are well known to influence causation or with considerable reason suspected to do so, and about which definite information can be obtained, and the study of the incidence of the disease in separate ships has been confined to the present year when the details of movements and of other conditions are available.

I.—The Connection of Attacks of Mediterranean Fever with Recent Stay in the Royal Naval Hospital, Bighi.

First and most important of the factors which are believed to have an influence in causation is:—

The connection of attacks of Mediterranean Fever with recent stay in the Royal Naval Hospital, Malta, either while suffering from other illness or as a member of the hospital staff.

This question has been investigated for the period from January, 1902, to the present year (1906), since this provides a quinquennial period, and one, moreover, in which the agglutination reaction and

the estimation of the dilution has been made use of as a routine method of diagnosis, the records being therefore correspondingly reliable.

(a) *As Patients under Treatment for other Diseases.*

The following table shows that every year a very considerable proportion of the naval cases, usually about one-third of those which come under treatment, have, at some time within the three months preceding onset, been in Bighi suffering from other illness.* It was, of course, necessary to investigate this previous hospital history for some definite period only, and three months has in consequence been taken as the limit, chiefly because it was found to include practically all the cases, as is shown in Table II.

Table I.—Showing the Proportion of Cases dealt with each Year which have been under Treatment in Bighi with other illness during the three months preceding onset.

Year.	Where under treatment.	Total cases dealt with, excluding relapses.	Proportion under treatment in preceding 3 months.
1902	In Bighi	293	83
	Elsewhere	—	—
1903	In Bighi	265	77
	Elsewhere	—	—
1904	In Bighi	259	95
	Elsewhere	—	—
1905	In Bighi	241	—
	Elsewhere	46	—
	Total	287	137
1906	In Bighi	120	—
	Elsewhere	55	—
	Total	175	79
	Grand total	1279	471

A few cases (21 in number) who were previously in hospital for illness which at the time was considered to be other than Mediterranean Fever, and was so classified, have been omitted from this table, either on account of the presence of a doubtful reaction during this first stay or because the subsequent history of the case has given reason

* The R. N. Hospital is situated at Bighi, and will be referred to throughout this paper under that name.

to doubt the accuracy of the original diagnosis. Moreover, in about a dozen of those included in Table I, the previous illness must be regarded as suspicious, although there was not sufficient evidence to justify amendment of the original diagnosis; but, with these exceptions, the patients may reasonably be looked upon as suffering from other illness. In deciding whether or not a previous illness was the first manifestation of Mediterranean Fever, one has to take into account the fact that it is not uncommon for the initial symptoms to reflect the previous medical history. Thus, in a case preceded by otorrhœa, the onset was signalised by a recurrence of the ear discharge; a second, with a history of head injury and resulting frequent headache, started with an epileptiform seizure; and records of more than one abscess or other surgical case have been met with where local recurrences accompanied the first signs of illness. After all, it is not extraordinary that a generalised infection should proceed along the line of least resistance.

The consistency with which so large a proportion of Mediterranean Fever cases present a similar history for a series of years disposes of the possibility of mere coincidence, but the following facts are also strongly suggestive that the majority of these cases were actually contracted in Bighi.

As is shown in Table II, a very considerable proportion may be regarded as almost certainly contracted there, and this, together with the enormous incidence among the sick berth staff constantly resident (*vide* p. 44), shows that the risk of infection is unusually great, and argues for a similar causation in the other cases.

A list, giving a short history of cases almost certainly contracted in hospital, follows. In this no patient has been included in whom there is not a history of at least 21 days' residence, with other illness before onset (the majority being far longer), or, among those who have been discharged, where the onset has occurred more than eight days after leaving. For 1905 and 1906 lists have kindly been provided by Staff-Surgeon Whiteside, but for previous years it has been necessary to consult the case sheets, and, owing to the longer limit of time, the number is smaller than that given by Dr. Johnstone in Part II of these Reports. If anything, therefore, it is probably under-estimated.

List of Cases almost certainly Contracted in Hospital.—1. W. P., Str.—Admitted to B 2 Ward on November 20, 1901, with venereal bubo, mass of protruding glands and slight temperature. Glands removed November 23 and temperature fell to normal and remained till February 20, 1903, 92 days after admission, when he had nausea, vomiting, and pyrexia for three days. Second rise of temperature, May 4, and on the 12th he reacted.

2. F. J., Str.—Admitted to E 1 Ward on January 29, 1902, with a broken down bubo. Operation February 26 and temperature normal till March 15, 46 days after admission, when he had temperature, anorexia, and pain in knee for three days.

Second operation April 13 followed by temperature and headache for 10 days. On May 31 fever returned and his serum reacted 1 in 40.

3. T. Q., Sigln.—Admitted to E 1 Ward on February 18, 1902, for hernia, for which operation was performed on 27th. He was well till April 13, 55 days after admission and when wound was healed. He then developed malaise and pyrexia and gave reaction 1 in 40 on April 17.

4. D. N., Lg. Seaman.—Admitted to E 2 Ward on February 25, 1902, with gonorrhœa. No developments till May 5, 70 days after admission, when he had headache and pyrexia and gave a positive reaction on May 13.

5. T. T., A.B.—Admitted to E 1 Ward on June 27, 1902, with simple fracture of both bones of leg. On July 19, coincident with an abscess of the leg and falling on incision of latter he developed fever and on August 4 this once more occurred. On August 24, 58 days after admission, he developed high temperature and headache, and on the 26th gave positive reaction.

6. R. H., Petty Officer.—Admitted on May 31, 1902, to E 1 Ward with a simple fracture of femur. Did well till August 27, 89 days after admission, when he had fever and headache for three days. Normal till October 23, when he had a recurrence of symptoms and reacted 1 in 50.

7. E. M., Petty Officer.—Admitted on July 29, 1902, to E 1 Ward with a compound fracture of lower third of femur, involving knee joint. By August 12 the wound was healed and he was up on crutches in September, but on October 11 he developed temperature and headache and reacted next day.

8. A. H., Yeoman of Signals.—Admitted to Zymotic Block on August 4, 1902, with a typical attack of enteric, giving negative reaction with *Micrococcus melitensis*. His temperature was normal by September 2, and so remained till October 15, 73 days after admission, when he had headache and persistent fever. Marked positive reaction on October 22.

9. P. H., Pte.—Admitted to E 1 Ward on August 27, 1902, with a lacerated wound of thumb. Three days' temperature and headache on September 23, 29 days after admission. Wound was healed by October 18 and on the 20th he had a return of symptoms and reacted 1 in 50 on the 22nd.

10. C. A., Signal boy.—Admitted on September 5, 1902, to E 1 Ward with a compound fracture of leg. On October 22, 47 days after admission, he developed fever, headache, etc.

11. G. W., G.M.A.—Under treatment in ship for months for eczema and was admitted on October 8, 1902, to E 1 Ward. On November 14, 36 days after admission, he developed headache and fever and reacted on December 22.

12. W. K., Cook's Mate.—Admitted on December 25, 1901, with multiple fracture of jaw. Wired on 30th. Had abscess at angle, with some fever on February 5. On April 10, 107 days after admission, he had malaise, headache and fever and reacted on April 15, 1 in 40.

13. W. S., Str.—Admitted to E 1 Ward on March 6, 1902, with hæmorrhoids, for which operation on March 11. On April 5, 30 days after admission, he complained of vertigo and temperature rose on 9th. Reaction on April 17.

14. H. T., Pte.—Admitted on June 30, 1902, to E 2 Ward with acute gonorrhœa. On July 26, 27 days after admission, had headache and fever and reacted on August 3.

15. E. M., Str.—Admitted on October 3, 1902, to E 2 Ward with gonorrhœa and epididymitis. On December 16, 75 days after admission, complained of abdominal pain and diarrhœa and had fever. He reacted on December 28.

16. H. B., Petty Officer.—Admitted on December 5, 1902, to E 1 Ward with multiple injury. On January 13, 1903, he developed headache and fever for a day or two, 39 days after admission, and on February 21 had a wave of fever with rigors, sweats, etc.

17. C. C., Pte.—Admitted on December 5, 1902, to E 1 Ward with a fracture of the leg. He did well till February 22, 1903, when he developed headache and fever, 79 days after admission, and reacted 1 in 50 on the 24th.

18. H. B., A.B.—Admitted on December 26, 1902, to E 1 Ward with fracture of jaw and other injuries. On May 21, 146 days after admission, he had rise of temperature and rheumatic pains and gave a positive reaction on the 27th.

19. A. R., Petty Officer.—Admitted to W 2 Ward on November 27, 1902, with sciatica. Disease had persisted for months without other symptoms and there was a strong rheumatic history. On December 28, 29 days after admission, he developed fever and headache and reacted on December 31.

20. E. Y., Pte.—Admitted on November 24, 1902, with tumour in iliac region and symptoms of appendicitis. Had one or two days' malaise and pyrexia on February 10, 78 days after admission, and on the 21st a second wave with enlarged spleen. Iliac region again tender.

21. S. L., Str.—Admitted to E 1 Ward on January 12, 1903, with simple fracture. About February 6 had pyrexia lasting five days, with painful swelling of jaw which was incised. Tonsils swollen. This was 25 days after admission, and 48 days later he had pyrexia and recurrence of swelling. Positive reaction five days after.

22. P. P., Maltese Shipwright.—Admitted to E 1 Ward on February 2, 1903, with a compound dislocation of the thumb. On March 9, 35 days after admission, had a rise of temperature, malaise, and vertigo. Reacted on March 14.

23. T. K., Str.—Admitted to W 2 Ward on March 28, 1903, with hæmaturia and dullness in left flank. Temperature normal. On April 28, 31 days after admission, developed fever and headache. Gave definite reaction on May 29.

24. I. J., Str.—Admitted to E 1 Ward on April 9, 1903, for hernia. After operation on May 7, 29 days later, the temperature never fell properly and on May 20 blood yielded a positive reaction.

25. H. L., Ord. Seaman.—Admitted to W 2 Ward on March 31, 1903, with pain over liver and jaundice. This had been preceded by inflammation of scrotum and liver enlargement followed. Temperature normal and steady improvement till April 21, 22 days after admission, when he developed temperature with pain in right flank and all over. Reacted on April 26.

26. W. S., Ord. Seaman.—Admitted to W 2 Ward, after several attacks of tonsilitis, for operation. Removed on April 13. On April 24, 24 days after admission, developed fever and headache. Reacted on May 11.

27. P. W., A.B.—Admitted to E 1 Ward on June 8, 1903, with ischio-rectal abscess. Steady improvement after operation, but on August 3 headache and diarrhœa began, and on August 10 his temperature rose and he reacted on the 16th. Onset 56 days after admission.

28. J. M., Str.—Admitted to E 2 Ward on July 18, 1903, with a suppurating patellar bursa. On August 11, 24 days after admission, there was slight pyrexia of nine days' duration with no symptoms. September 8, fever of a week's duration. September 21, the femoral glands, which had become enlarged on August 3, were opened up. This was at once followed by a rise of temperature and a positive reaction was obtained two days later.

29. W. F., Petty Officer.—Admitted to W 2 Ward on May 1, 1903, with well-marked signs of pleurisy and pericarditis. By June 3 was fairly well, but on this date, 34 days after admission, a slight rise of temperature occurred which persisted, and on June 23 he complained of pains all over. June 25 reacted 1 in 50.

30. E. A., Yeoman of Signals.—Admitted to C Ward on November 3, 1903, with hernia, for which operation performed. Healed by November 19, but on January 9, 1904, 67 days after admission, he had sudden rise of temperature and reacted next day 1 in 200.

31. J. F. C., G.M.A.—Admitted to E Ward on November 26, 1903, with otorrhœa, temperature normal. Quite well till February 10, 76 days after admission, when he developed headache and fever. Reacted on February 12, 1 in 50.

32. T. B., Ord. Seaman.—Admitted to E Ward on December 5, 1903, with discharge from ear. No temperature except 99°·2 on January 14, 1904, until January 31, 57 days after admission, when he had vomiting, headache and fever. Reacted next day 1 in 200.

33. E. S., Str.—Admitted to E 3 Ward on December 8, 1903, with enteric fever. Temperature fell about end of January, 1904, and he did well till February 24, 78 days after admission, when had rise of temperature. Reacted next day 1 in 50.

34. A. S., Ord. Seaman.—Admitted to E Ward on November 7, 1903, with ulcers of legs and enlarged glands. He was well till April 2, 146 days after admission, when he had rigors, fever and headache. Reacted next day 1 in 50.

35. A. L., Able Seaman.—Admitted to B Ward on December 15, 1903, for gonorrhœal rheumatism. Temperature rose about January 16, 1904, 32 days after admission, and a positive reaction was obtained the same day.

36. F. S., G.M.A.—Admitted to C Ward on December 16, 1903, with a contusion of thigh. Symptoms of fever first appeared on February 16, 1904, 62 days after admission, and a positive reaction was obtained the same day.

37. T. D., Able Seaman.—Admitted to B Ward on December 22, 1903, with gonorrhœa. No symptoms till January 14, 1904, 24 days after admission, when he developed fever, headache and shivering. This passed off rapidly, but recurred on February 10. Reaction present on January 14.

38. C. B., Stoker.—Admitted to C Ward on January 4, 1904, with a compound fracture of leg. Doing well till February 13, 40 days after admission, when there was a rise of temperature and headache for two days. This recurred on February 26 and reaction was present.

39. W. F., Able Seaman.—Admitted to E Ward for hæmorrhoids on January 19, 1904, which were removed on January 23. On February 13, 25 days after admission, there was a rise of temperature and headache, and the blood reacted in a dilution of 1 in 100.

40. J. N., Private.—Admitted on January 21, 1904, to C Ward for hernia, for which an operation was performed on January 27, the wound healing nicely. On February 27, 37 days after admission, there was a rise of temperature and headache, and the blood was found to react 1 in 10.

41. J. R., Private.—Admitted on January 25, 1904, to C Ward with a fracture of olecranon. On February 17, 24 days after admission, he developed headache and temperature, and gave a positive reaction next day.

42. C. S., Stoker.—Admitted to B Ward on April 7, 1904, with primary syphilis. Was all right until May 21, when he complained of headache and temperature rose. This was 44 days after admission, and three days later his blood gave a positive reaction.

43. E. J. S., Able Seaman.—Admitted on May 23, 1904, to W 1 Ward with well-marked attack of appendicitis and negative reaction. Was convalescent by June 24, but on July 6, 44 days after admission, he developed headache and showed a positive reaction.

44. M. H., Petty Officer.—Admitted on July 10, 1904, to A Ward with gonorrhœa. No symptoms till August 30, 51 days after admission, when he developed a temperature and headache. First reacted 1 in 300 on September 20.

45. B. M., Ordinary Seaman.—Admitted to E Ward on February 27, 1904, with rectal abscess. Operation on February 27, and temperature fell at once. Did well till April 19, 51 days after admission, when temperature suddenly rose, and a positive reaction was obtained next day.

46. D. M., Petty Officer.—Admitted on March 10, 1904, to Ward W 1 with definite signs of tubercle, T. B., in sputum. Was doing well and gaining weight, but about April 19, 40 days after admission, got rise of temperature and headache. Positive reaction on April 25.

47. T. D., Private.—Admitted on July 11, 1904, to Ward W 1 with well-marked symptoms and signs of pericarditis. This cleared up, but temperature began to rise about August 4, 24 days after admission, and from that time he had irregular pyrexia. First reacted on October 3.

48. B. B., Fitter.—Admitted on September 7, 1904, to A Ward with chancroid and bubo. On December 6, 90 days after admission, developed headache and high temperature. Reacted next day.

49. P. S., Able Seaman.—Had had a non-venereal bubo in his ship since June and was admitted with it to hospital on October 1 to D Ward. Glands extirpated on October 18, but no symptoms till November 23, 53 days after admission, when wound had healed. Then headache and rise of temperature and positive reaction.

50. A. H., Able Seaman.—Sick on board ship and in "Maine" since August 22 with a bubo and admitted to hospital on October 1 to D Ward. No symptoms till November 23, when pain in back, followed by headache and fever, 54 days after admission. Positive reaction two days later.

51. C. H., Stoker.—Admitted on October 1, 1904, to D Ward with disease of ear. No other symptoms till November 12, when headache and rise of temperature. Positive reaction four days later.

52. T. B., Stoker.—Admitted to W 4 Ward on October 1, 1904, with signs of phthisis, no temperature, but history of hæmoptysis. On November 17, 48 days after admission, developed chills, rise of temperature and so on, and gave a positive reaction on November 22.

53. J. McG., Stoker.—Admitted to A Ward on October 12, 1904, with gonorrhœa. On December 2, 51 days after admission, complained of headache and nausea, and had rise of temperature. Reacted on December 4.

54. C. R., Able Seaman.—Admitted to D Ward on October 28, 1904, with a simple fracture of leg. Began to feel ill about December 25, 57 days after admission, and first reacted on December 27.

55. B. I., Lg. Stoker.—Admitted to D Ward on December 4, 1903, with fracture of lower jaw. Wired on January 28, and on February 11 had swelling and tenderness at ankle and on next day fever and inflammation of pharynx and tonsil. Well by 18th, but had temperature again on February 21, and on April 2 had recurrence and gave positive reaction. First symptoms 70 days after admission.

56. J. McC., Private.—Admitted to B Ward on January 12, 1904, with syphilis primary. Doing well till February 6, when had headache and rise of temperature, 25 days after admission. Reacted five days later.

57. G. S., Stoker.—Admitted to E Ward on December 9, 1903, with an abscess of the chest wall. Improved greatly and was all right till January 24, 46 days after admission, when he developed sickness and fever. Reacted on February 11.

58. E. H., Able Seaman.—From October 17 to November 13, on board, sick with œdema of tonsils and was admitted on November 19, 1904, with well-marked diphtherial paralysis. Had one day's rise of temperature on November 21, but was then normal till December 24, 35 days after admission, when he developed fever and general pains and reacted on January 14.

59. T. R., Stoker.—Admitted to C Ward for hernia on October 11, 1904, and had operation on October 15. On December 3, 53 days after admission, developed high temperature and headache, and reacted on December 5.

60. W. W., Able Seaman.—Admitted to sick list on November 6 with bronchitis, and said he had night sweats, but no temperature at any time. Admitted to W 1

Ward on November 22, 1904, and had similar symptoms in hospital until January 21, when he developed headache, temperature and pains, 60 days after admission. Reacted on January 28.

Cases with Onset within Eight Days of Discharge.—1. R. G., Boy.—Was under treatment from February 28 to April 17, 1902, with abscess, and onset occurred five days after leaving.

2. A. M., Stoker.—Was under treatment in E 2 from April 10 to June 2, 1902, for scabies, and onset was seven days after leaving.

3. E. E., Chief Stoker.—Was under treatment for internal hæmorrhoids from June 11 to July 29, 1902, in E 1 Ward and symptoms probably began two days before leaving, but case is a little doubtful.

4. W. T., Chief Stoker.—Under treatment in E 1 Ward from May 20 to July 24, 1902, for hernia. Symptoms began at once on discharge.

5. W. B., Able Seaman.—Under treatment in W 1 Ward and afterwards Zymotic from August 1 to October 8, 1902, with enteric. Onset the day following discharge.

6. G. H. D., Able Seaman.—Under treatment in Zymotic Ward for enteric fever from August 1 to October 17, 1902. Onset the day after discharge.

7. A. F., Able Seaman.—Under treatment in E 1 Ward from October 10 to November 21, 1902, with fracture of jaw, and became ill at once on leaving hospital.

8. W. H. D., Stoker.—Under treatment in B Ward from May 10 to July 5, 1903, with syphilis primary, and symptoms began eight days later.

9. Mr. J. H., Lieutenant.—Under treatment in C Cabin from November 1 to November 25, 1903, with injury to knee, and symptoms began the day previous to discharge.

10. F. P., Ordinary Seaman.—Under treatment in A Ward from September 28 to December 16, 1903, with syphilis primary, and was never well after discharge.

11. F. C., Able Seaman.—Under treatment in D and C Wards from September 10 to October 31, 1904, with operation for hammer toe, and developed symptoms four days after discharge.

12. W. G., Stoker.—Under treatment in B Ward from October 1 to November 18, 1904, with syphilitic bubo, and developed symptoms four days later.

13. P. C., Stoker.—Under treatment in B Ward from October 12 to November 18, 1904, with chancroid, and developed symptoms eight days after discharge.

14. Mr. H. L. D., Commr.—In C Cabin from November 14 to November 28, 1904, with fissure of anus, and developed Mediterranean Fever seven days later.

List of Patients who have actually developed Mediterranean Fever while in Hospital for other Diseases during 1905–6, given by Staff-Surgeon Whiteside.

Name.	Rating.	Wards.	Disease on admission.	Date of admission.	Onset.	Interval in days.
W. B.	E. R. A.	F ……… D, Feb. 7……	Disease of skin	Jan. 26	Mar. 10	43
J. H.	Ch. Str.	F ……… D, Feb. 7……	„ bone	„ 26	Apr. 12	76
J. M.	Str.	A ………	Syphilis, prim.	Mar. 8	May 20	73
W. W.	S. Batt.	E 4 ………	Enteric fever …	„ 15	„ 4	50
H. M.	G. M. A.	B ………	Syphilis, prim.	„ 20	June 1	73
H.H.M.	Pte.	W 1 ……… W 2, Apr. 26 W 1, May 15	Pneumonia ……	Apr. 15	„ 5	51
W. B.	G. M. A.	As above ……	„ ………	„ 14	May 19	35
R. T. S.	Lg. Sn.	As above ……	Heart disease …	„ 14	„ 28	44
R. B.	A. B.	D ………	Abscess ………	„ 17	June 9	53
C. P.	C. P. O.	C ……… D, Apr. 24 …	Fractured jaw	„ 17	May 31	44
T. Q.	Str.	C ………	Hernia ………	„ 20	June 9	51
A. C.	A. B.	W 2 ………	Laryngitis ……	„ 29	„ 2	35
J. H.	Str.	D ………	Abscess ………	„ 29	„ 10	43
S. S.	A. B.	D ………	„ ………	May 1	„ 9	39
J. L.	Str.	A ………	Sec. gonorrhœa	„ 4	„ 4	31
H. W.	C. crew	C ………	Fracture, Potts'	„ 21	July 5	45
E. B.	A. B.	Zymotic …… E, Aug. 3 … F, Aug. 7 …	Scarlet fever …	June 7	Aug. 7	61
J. A.	Lg. Sn.	C ………	Varix ………	Aug. 29	Sept. 20	23
T. L.	Pte.	A ……… F, Nov. 6……	Chancroid ……	Oct. 10	Nov. 29	50
T. B.	Pte.	A ………	„	Aug. 28	Oct. 9	42
A. J.	Pte.	A ………	„	„ 28	„ 11	44
W. T.	A. B.	B ………	Syphilis, sec. …	Oct. 1	Nov. 14	44
W. K.	A. B.	F ………	Chancroids ……	Nov. 9	Jan. 7	59
P. S.	Str.	B 2 ………	Disease of eye…	Oc 1	„ 12	103
H. B.	Lg. Str.	E 2 ………	Bronch. asthma	Jan. 27	Mar. 6	38
S. T. G.	Pte.	B ……… F, Jan. 30 … A, Feb. 19 …	Bubo, venereal	„ 27	„ 14	46
A. R.	Str.	A ……… F, Feb. 9 … A, Feb. 19 …	Syphilis, sec. …	„ 30	„ 12	41
A. P.	Str.	A ………	Gonorrhœa ……	Dec. 12	Feb. 5	55
C. M.	Str.	B ……… F, Jan. 10 … A, Feb. 19 …	Syphilis, prim.	„ 23	Mar. 6	45
G. C.	Signl.	A ……… B, Feb. 19 …	Gonorrhœa ……	„ 26	„ 13	77
H. J.	Str.	B ……… A, Mar. 23 …	„	„ 23	„ 24	91

List of Patients who developed Mediterranean Fever within Eight Days of Discharge after Treatment for other Disease during 1905–6.

Name.	Rating.	In hospital previously.	Wards.	Disease.	Date of onset.	Interval in days.
P. D.	O. S.	Feb. 16 to Apr. 17	C	Hernia	Apr. 25	8
W. L.	A. B.	Mar. 8 „ May 9	E 4	Enteric	May 11	2
G. R.	Str.	May 26 „ July 20	{W 1 / E, June 21}	Colitis	July 24	4
J. McL.	A. B.	Aug. 26 „ Oct. 18	A	Chancroids	Oct. 21	3
A. M.	A. B.	Apr. 26 „ May 30	D	Fracture	June 3	4
J. M.	Fitter	Mar. 14 „ June 2	D	Wound	May 28	Nil
R. B.	B'ksmith	Oct. 4 „ Nov. 6	D	Hæmorrhoids	Nov. 9	3
H. F. C.	A. B.	Feb. 6 „ Apr. 26, 1906	{B / A, Mar. 23}	Syphilis, sec.	Apr. 19	3

Patients who developed Mediterranean Fever at varying Intervals after discharge from Bighi.—In addition to the number included in this list, the onset of the disease in very many more occurs within a few weeks of discharge, and the number proportionately diminishes in accordance with the period which has elapsed since leaving. This is well brought out in the following table, and also points strongly to some etiological influence connected with Bighi :—

Table II.—Showing the Numbers of Patients under Treatment for other Illness who developed Mediterranean Fever at varying intervals after discharge from Bighi.

Year of onset.........	1902.	1903.	1904.	1905.	1906.	Total.
Within a month—						
While resident	20	11	29	22	9	91
Within 8 days of discharge ...	7	2	5	7	1	22
From 8 days to a month	18	22	23	45	22	130
Between 1 and 2 months	22	25	30	45	30	152
„ 2 „ 3 „	16	17	8	18	17	76
„ 3 „ 5 „	5	6	1	4	4	20
Total	88	83	96	141	83	491—20

Two possible explanations of this heavy incidence among patients recently discharged from Bighi must here be discussed. It has been argued, in the first place, that the debility produced by the illness which occasioned their stay reduces the natural resistance so much that they become a ready prey to the disease on subsequent exposure to infection.

Many facts, however, militate strongly against this hypothesis. For one thing, men in naval hospitals are not discharged until they are fit for duty, and in many cases a considerable interval of apparently perfect health has intervened between discharge and the onset of symptoms. Not only is this the case, but Table VII (p. 36) shows quite distinctly that liability is as great after non-debilitating disease such as otorrhœa, simple tumour, and so on, as after many more exhausting ailments. Again, attacks of Mediterranean Fever are by no means confined to patients who remain on the station; they occur with as great frequency among those invalided, who only leave hospital to embark for passage to England. Included in Table I are 25 cases of this description during 1905–6, of which 11 had onset within a month of discharge, 12 within two months, and two within three months. Similarly, a few cases are included where, owing to the departure of the Fleet, patients have been sent to their ships while only convalescent, and have developed their symptoms without landing anywhere. These show similar intervals. Under both these heads there are, of course, chances of infection in the ship, but it may at least be said that the possibilities are greatly lessened by the exclusion of shore infection. The results of enquiry into the movements of patients between discharge from hospital and onset of illness, as detailed at p. 100, may be referred to as illustrating that the opportunities of exposure ashore are, in the majority of cases, quite limited.

A second attempted explanation for the special liability of hospital patients is that a latent infection is stirred into life by the debilitating influence of other illness. There are grounds for supposing that this does occur under certain circumstances, but in the present instance the evidence goes to prove that it is at least infrequent. The onset of disease would in that case correspond with the date of an injury or of an operation rather than occur long after the wound was healed. Besides, the proportion of officers (among whom the disease is far more common than among the men) who have been in hospital previously is, as will be seen later, a very small one. There seems no reason to suppose that debilitating circumstances should be more necessary to produce the disease in the seaman than in the officer.

It will be seen in Table XXIV (p. 74) that since April, 1906, coincident with the cessation of the occurrence of cases while resident in hospital, or within eight days of discharge, there has not only been a fall in numbers in the fleet generally, but no single case admitted has given a history of hospital residence within the preceding three months. This is a very striking and significant fact.

Nevertheless, to those who believe in an incubation period of rigidly definite duration, the acceptance of a relationship between residence in hospital and the occurrence of disease some six weeks to

three months later will be difficult. It must, however, be remembered that in experiments on animals the doses used have been large, and the occurrence of infection has been mapped out by continual and systematic examination for agglutination and not merely by the onset of symptoms which, indeed, need not necessarily occur. It is true that man is said to be more susceptible than animals, but there is nothing in these experiments to negative the possibility that he also can become infected without the occurrence of very definite symptoms. The subject is discussed at greater length elsewhere.

Symptoms Suggesting Earlier Infection.—With a view to the discovery of symptoms suggesting infection at an earlier stage in the history of these 471 cases, included in Table I, the hospital sheets of the majority of them were examined, with the result that about 47 were found to have exhibited symptoms at some time or another during their stay for which no very obvious explanation was forthcoming from their condition at the time. The following provide illustrative examples.:—

W. T., Ch. Str.—Admitted for hernia May 20, 1902. Operation May 28. Healed by June 13 and allowed up. On July 8 had temperature and malaise lasting four days, with joint pains. Said he was never well after discharge on July 24, and August 23 was placed on sick list. Admitted October 9.

W. R., Str. -Admitted March 21, 1903, with gonorrhœa and perineal abscess. On incision of latter temperature fell to normal, but on April 7 temperature 101° and rigor. Wound healthy. Temperature persisted till 13th. Negative reaction. He was discharged on May 13, and on June 17 had first symptom of Mediterranean Fever.

H. B., Ordinary Seaman.—Admitted February 3, 1906, with venereal sore. Developed temperature, and headache March 16 and 17, but with negative reaction. Onset April 18 after discharge on March 27.

J. S., Str.—Admitted November 24, 1905, with chancroid and bubo. Developed a temperature and abdominal pain January 3, 1906, and headache, abdominal pain and temperature January 25. Discharged February 1, and onset of Mediterranean Fever on May 12.

It will be noted that in the list of cases contracted while still resident in hospital a very similar history is frequently given—a short preliminary canter in the shape of two or three days' temperature and malaise, followed in a few weeks by more definite symptoms and positive reaction.

It will be seen from this table that the difference is enormous, more particularly when it is taken into consideration that the Fleet number represents only the average, whereas the hospital number represents the actual total of individuals, and, moreover, that even this is over estimated, since several patients are admitted more than once during the year. One is, therefore, perfectly safe in asserting that, in the past, residence in Bighi for any other illness has enormously increased liability to the development of Mediterranean Fever within the next three months.

Table III.—Comparing the Incidence of Mediterranean Fever among previous Patients in Bighi and those in whom no History of Connection with that Establishment was to be obtained.

Year	1902.	1903.	1904.	1905.	1906.
Actual number of admissions to Bighi of patients suffering from illness other than Mediterranean Fever	1,284	1,158	1,346	1,480	261*
Actual number of these who subsequently, either during residence or within three months of discharge, are known to have developed Mediterranean Fever	96	85	86	170	28
Average number of men victualled in Mediterranean fleet yearly	18,470	18,410	19,590	14,360	—
Proportion of fever cases dealt with yearly, showing no previous hospital history	190	155	144	150	80

* First quarter only of 1906.

In addition, an examination of Tables IV and VII and Charts 1 to 5 shows quite conclusively that those cases, classed as almost certainly contracted in hospital, display a remarkable correspondence with those who merely developed it subsequently to discharge, both with regard to the time at which they were resident and presumably contracted the disease, the blocks in which they were treated, and the kind of illness from which they suffered.

To summarise:—

That large numbers of cases have year by year been contracted in Bighi is a well-authenticated fact.

A large proportion of cases admitted during each year give a history of recent residence there, and it is equally certain that liability to attack in the near future is very much greater among patients there than among the generality of their messmates.

In a great many the possibilities of exposure to infection between discharge and the onset of symptoms have been practically negligible. It is not therefore unreasonable to conclude that the majority of these persons have been infected while actually in hospital.

Description of Bighi Hospital.—In order to throw light on the method of infection in these cases, it is necessary to give a short description of the hospital and of some points with regard to the routine in force there. The grounds comprise an area of about 17 acres on a broad bluff of land some 50 feet above sea level, and projecting into Bighi

Bay on the southern side of Grand Harbour and between Rinella and Calcara Bays. Except, therefore, on the south-eastern side, it is entirely cut off from the adjoining land by broad strips of water, and is consequently separated from the thickly populated centres—the nearest, Vittoriosa, being at the least 260 yards distant. Ricasoli Fort to the north-east is 140 yards from the nearest point of the hospital, and Valletta is 700. The hospital proper, as opposed to the residential area, is on the north-west side, and is therefore furthest removed from the small village of Calcara, which adjoins the southern corner of the grounds, and is the only inhabited district that does so. The rest of the country adjoining is practically uninhabited, and herds of goats provide the only possible source of infection. It is obvious, therefore, that this is to be sought within the establishment itself.

The hospital proper originally consisted of two large one-storey blocks and of a central block. The former, which contains one large and two small wards on each side, separated by a broad central corridor, are known as the East and West Blocks respectively, and will be so referred to. They also contain cabins for officers at the corners and the basements are taken up for kitchens and other offices. Above these wards, under the eaves at each end, are two small rooms, now unused, but previously to October, 1902, the quarters of the Sick Berth staff. Just outside them and at the top of the stairway leading to them are large stone tanks, at present kept boarded up, but formerly open; these must have provided excellent breeding places for mosquitoes.

The wards have been modernised and are fitted with good sinks and latrines.

An infectious block was added on the western side in 1900, and a new general surgical block was first occupied in June, 1903. This latter block is three stories high, but, owing to the dip in the ground towards the Rinella side, where it is situated, its top storey is beneath the level of the old blocks.

Charts 1 to 4 also show that it is effectually screened from the west (the present Mediterranean Fever) block by the interposition of the east and central buildings. It consists for the most part of six large wards arranged in longitudinal series of twos. The ends and corners are filled in with small wards, the various offices, and cabins. Both this and the infectious block are built on modern lines and do not call for further remark in this direction.

On the southern or landward side of the grounds are the various quarters and residences, and the unoccupied areas are utilised as gardens or as asphalted catchment areas for the supply of the underground tanks. For this reason Bighi is singularly free from dust, and, owing to its encirclement by water, receives very little from without.

The arrangements for water supply constitute a noteworthy feature, as, owing to the insufficiency of the public supply or aqueduct for fire purposes, it is necessary to store water in a series of tanks.

Drinking water is supplied to all parts of the hospital from the aqueduct in iron pipes, the various taps being clearly labelled, "Fit for Drinking," but for the water for fire, lavatory, flushing, and garden purposes there are several distinct sources. First, there are 36 underground tanks, many entirely unused, and therefore containing water which is stagnant and full of vegetable matter. These are supplied by surface water, for which catchment areas are provided by the flat roofs of the hospital buildings and the asphalted surfaces of the grounds already referred to, while seven of them also have a supplementary supply from the aqueduct, the pipes being controlled by stop-cocks. No. 14 tank, situated close by the laundry, is used as a reservoir from which water is pumped by an engine near here into flushing tanks on the roofs of the various residences and of the Refractory, Zymotic, and Central Blocks, and also into the stone tanks already referred to as being under the roofs of the East and West Blocks. This water is used for lavatory and flushing purposes. In addition, there is a second pumping station on the Calcara side, below the Zymotic Block, which three times a week fills a third series of seven tanks, three each on the roof of the East and West Blocks and one on the Surgical, with sea water. This is used solely for the purpose of giving the drainage an additional flush, and is turned on once a day for five minutes, while at the same time those blocks and residences unprovided with the sea-water tanks are flushed by the fresh-water supply mentioned.

This brief description illustrates the fact that collections of more or less stagnant water are exceedingly numerous about the hospital grounds and buildings, and to these must be added a large number of garden surface tanks and tubs and the innumerable gullies connected with surface drainage. It also affords evidence that there is ample provision for flushing and that this essential procedure is thoroughly and regularly carried out.

Drainage.—The main drain is contained in a capacious tunnel which pierces the solid rock from the Rinella side to join the Government sewer at the southern corner of the grounds. The drainage from the Zymotic, East and West Buildings, join at their northern end and sweep round on the southern side of the Surgical Block to join the main drain at its northern end, so that the drainage from the Mediterranean Fever wards passes close to this building.

The drainage system is, however, every way up to date, is well supervised, and the arrangements for flushing are probably more satisfactory than almost any establishment in the island.

Sterilisation of Effects.—The clothing of Mediterranean as well as of infectious cases has for some time been sent to the disinfector on

admission, and where cases occur in the hospital, the regular procedure is that bedding and clothing are to be dealt with similarly.

Stringent regulations have been laid down with regard to disinfection of hands by the staff, after dealing with excreta of Mediterranean Fever cases.

The hospital may therefore be described as almost entirely isolated from the centres of population, unusually free from dust, built and administered on modern lines, and certainly in no way inferior in either respect to any hospital in the island, with a water supply above suspicion and a system of drainage which is found to work satisfactorily. There are, therefore, three main points which have a bearing on the question of the high incidence of Mediterranean Fever among residents there :—

First of all, in the close juxtaposition of sufferers from Mediterranean Fever with cases of other illness we have a large amount of susceptible material in the near neighbourhood of a possible source of infection.

Second. Mosquito breeding places are unusually numerous.

Third. The hospital has for years been supplied with goats' milk containing *Micrococcus melitensis*, and from the work of Staff-Surgeon Whiteside, referred to later, it is definitely known that this was, at least occasionally, drunk unsterilised.

The probable methods of infection resolve themselves, therefore, into direct or indirect contact, contamination of food-stuffs by various flies or their droppings, inoculation by biting flies, and ingestion of naturally infected milk.

Distribution of Mediterranean Fever Cases in Bighi Hospital, and Effect of Propinquity on other Patients.—With reference to the procedure adopted in isolating Mediterranean Fever, fortunately, during the period 1902 to 1906, different buildings have at various times been appropriated for the accommodation of these cases. A unique opportunity is thereby afforded for studying the influence of propinquity to the potential sources of infection in the production of the disease among other patients. It must be premised that before the introduction of an observation ward in June, 1905, the Mediterranean Fever block did not include absolutely all cases of the disease in hospital, as, in addition to undiagnosed cases under observation in the general medical wards, an occasional officer or man developing the disease elsewhere does not appear to have been transferred. For all practical purposes, however, the enormous bulk of infective material was to be found in these special wards, and it is justifiable to assume therefore that here, too, would be found the principal danger of contraction of the disease by contact or biting flies. Table IV, illustrated in the Charts 1 to 4, gives a history of the blocks, the approximate number of persons exposed in them, and the proportion who subsequently developed the

disease. It will be seen that the five years must be divided into four periods :—

(1) No isolation. Fever cases in general medical wards W 1 and W 2.

(2) Almost complete isolation. Fever cases in special ward W 1.

(3) Almost complete isolation. Fever cases in special wards E 1 and E 2.

(4) Complete isolation. Fever cases in special block (West), observation cases in special wards (W 3 and W 4) in this block.

In addition, therefore, to demonstrating the inefficiency of isolation by itself, which alone constitutes an argument against any form of contact infection, this table and the charts, pp. 27—32, show the following points :—

That equally during the first period when the cases were indiscriminately mingled with others, and during the second, when developed cases were kept together in one ward, the block which suffered most severely was the East, as far removed as possible from the source of infection, and containing surgical cases. This, which is noted alike with the almost certain and with the other cases, may be taken as suggesting the improbability of infection by contact or biting flies, and the possibility of a place infection (since on each occasion the same block was affected), or of something in connection with the surgical nature of the cases. That being so, it is interesting to note that the third chart puts an end to the idea of place infection, since with the removal of the surgical cases to the new block a similar condition of affairs is found there also. But since the Mediterranean cases were at the same time removed to the East Block, it might be argued that this offered some support to the theory of convection by biting insects, dust, or other contaminate infection.

The last chart, however, offers a decided argument against this conclusion, since with cases far more satisfactorily isolated at one end of the hospital, and with an observation ward provided, the incidence still continues to be highest in the Surgical Block, although removed as far as possible from the source of infection and screened from it by the intervening Central and General Medical (East) Blocks.

The conclusion that is forced upon one from a study of these charts is, that while cases are very generally distributed there is a special incidence upon surgical wards, and that residence in them is of greater importance in determining the development of the disease than propinquity to the Mediterranean Fever cases.

Relationship to the Amount of Susceptible and of Infective Material in Hospital.—Chart 5 gives these relations in graphic form. It will be seen that there is no definite connection between the number of persons resident each month who subsequently develop fever and the average number of reservoirs of infective material, in the shape of cases of the disease who were under treatment during that month. In

To face p. 26.

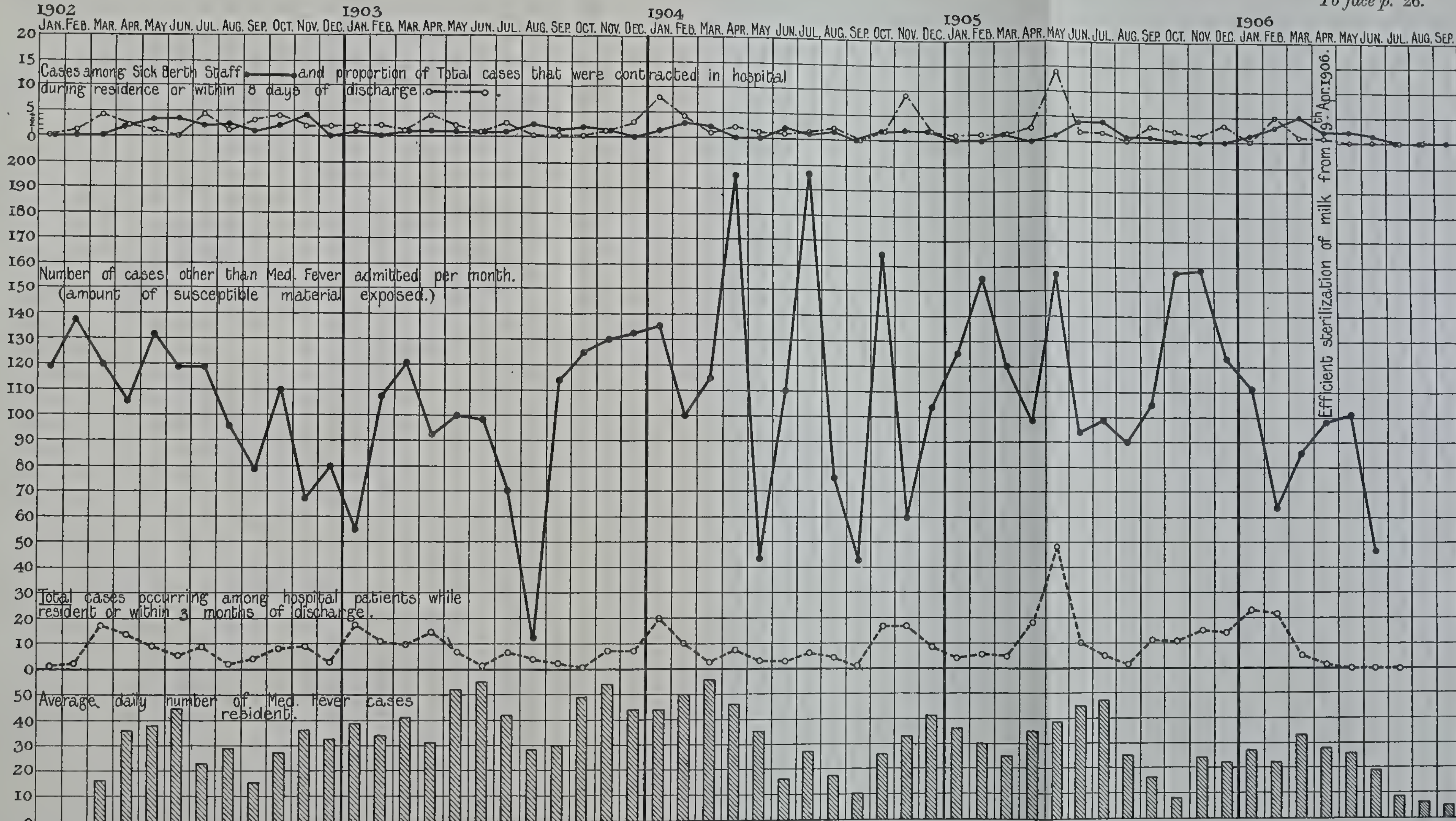


CHART 5.—Showing relationship between cases contracted in hospital and the amount of susceptible material (admissions of cases of disease other than Mediterranean Fever), and of infective material (average daily number of Mediterranean Fever cases) resident during the month in which the disease was probably contracted, from January, 1902, to September, 1906.

Note.—All cases, except among Sick Berth Staff, are placed under months in which they were resident in hospital and the disease was probably contracted.

Table IV (illustrated by Charts 1 to 4).—Giving, for each of the Four Periods dealt with, the approximate number exposed in each Block, the number known to have subsequently developed Mediterranean Fever, and the proportion (*in italics*) of those who almost certainly contracted the disease while in hospital.

Period.	Conditions.	West Block.			East Block.			Surgical Block.		
		Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.
January 1, 1902, to October, 1902	No isolation. West Block medical, East Block surgical	429 (m	13 edica	*1* l)	611 (surgic	52 al and sc	*15* abies)	N	ot ope	n
October, 1902, to end of June, 1903	Isolation begun. Mediterranean Fever cases in W 1 Ward. Observation cases in W 2	432 (m	26 edica	*5* l)	497 (surgic	41 al and sc	*11* abies)	N	ot ope	n
End of June, 1903, to June 22, 1905	Isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in W 1	1057 (m	64 edica	*9* l)	24 (enter	10 ic, Jan.,	*4** 1904)	1571	138	*45*
June 22, 1905, to end of first quarter, 1906	More complete isolation. West Block reserved for Mediterranean Fever	? (Medit	5 erranean Block)	— Fever	421 (gener	29 al medic Aug. 21)	*1* al from	814 (medical from Ju	74 cases in ne 20 to	*18* E and F Aug. 21)

* 3 enteric.

Table IV—*continued.*

Period.	Conditions.	Scabies Wards, Central Block.			Zymotic.			Refractory.		
		Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.	Approximate No. exposed.	No. subsequently developing Mediterranean Fever.	Of whom were almost certainly contracted.
January 1, 1902, to October, 1902	No isolation. West Block medical, East Block surgical	—	—	—	57 (including enteric)	5	4	19	—	—
October, 1902, to end of June, 1903	Isolation begun. Mediterranean Fever cases in W 1 Ward. Observation cases in W 2	—	—	—	36	4	—	17	—	—
End of June, 1903, to June 22, 1905	Isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in W 1	93	2	—	32	3	1	24	1	—
June 22, 1905, to end of first quarter, 1906	More complete isolation. West Block reserved for Mediterranean Fever	57	—	—	3 ?	1	1	5	—	—

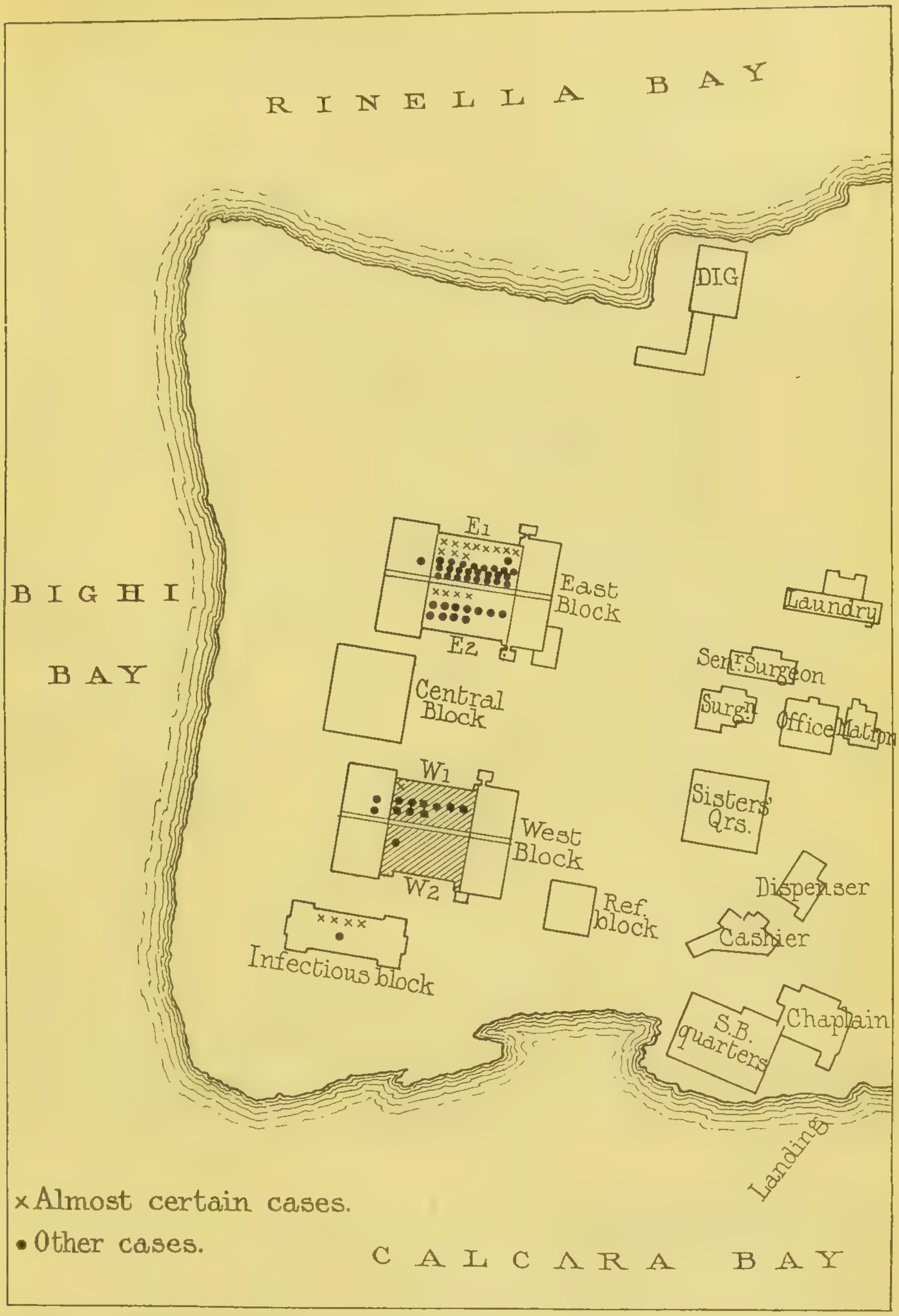


CHART 1.—*Period*—January to October, 1902. *Conditions*—No isolation. Mediterranean cases on W 1 and 2 with medical cases. Enterics frequently treated in Zymotic Block. W 1 and W 2, slightly shaded, show position of large majority of Mediterranean Fever cases.

	Cases.	Approximate number exposed.
In East Block	52	611
In West Block..................	13	429
In Infectious Block............	5	57

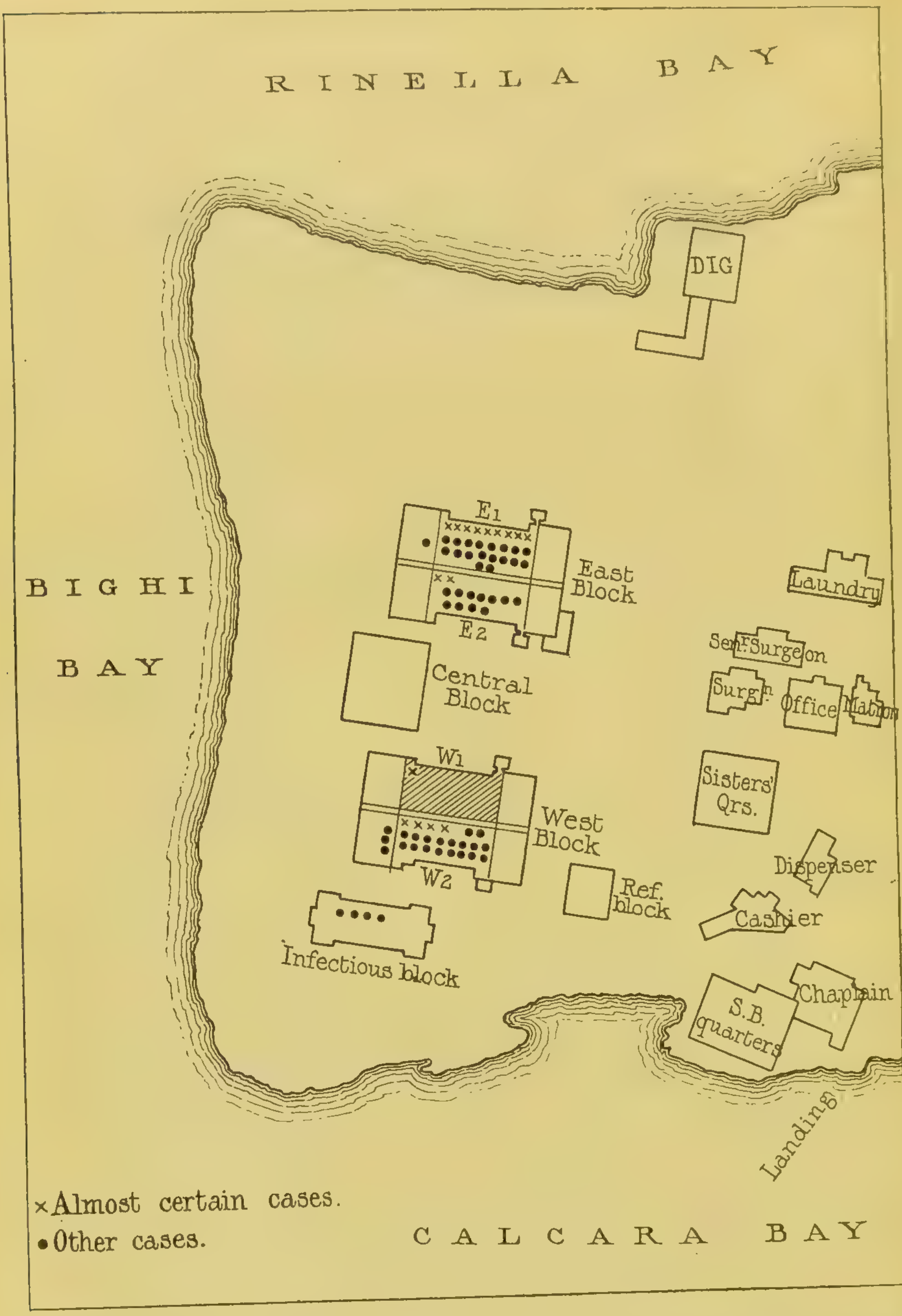


CHART 2.—*Period*—November, 1902, to June, 1903. *Conditions*—Fairly complete isolation. Mediterranean cases in W 1 ward. Observation cases with general medical cases in W 2 ward. Mediterranean ward shaded.

	Cases.	Approximate number exposed.
In East Block	41	497
In West Block...............	26	432
In Infectious Block.........	4	36

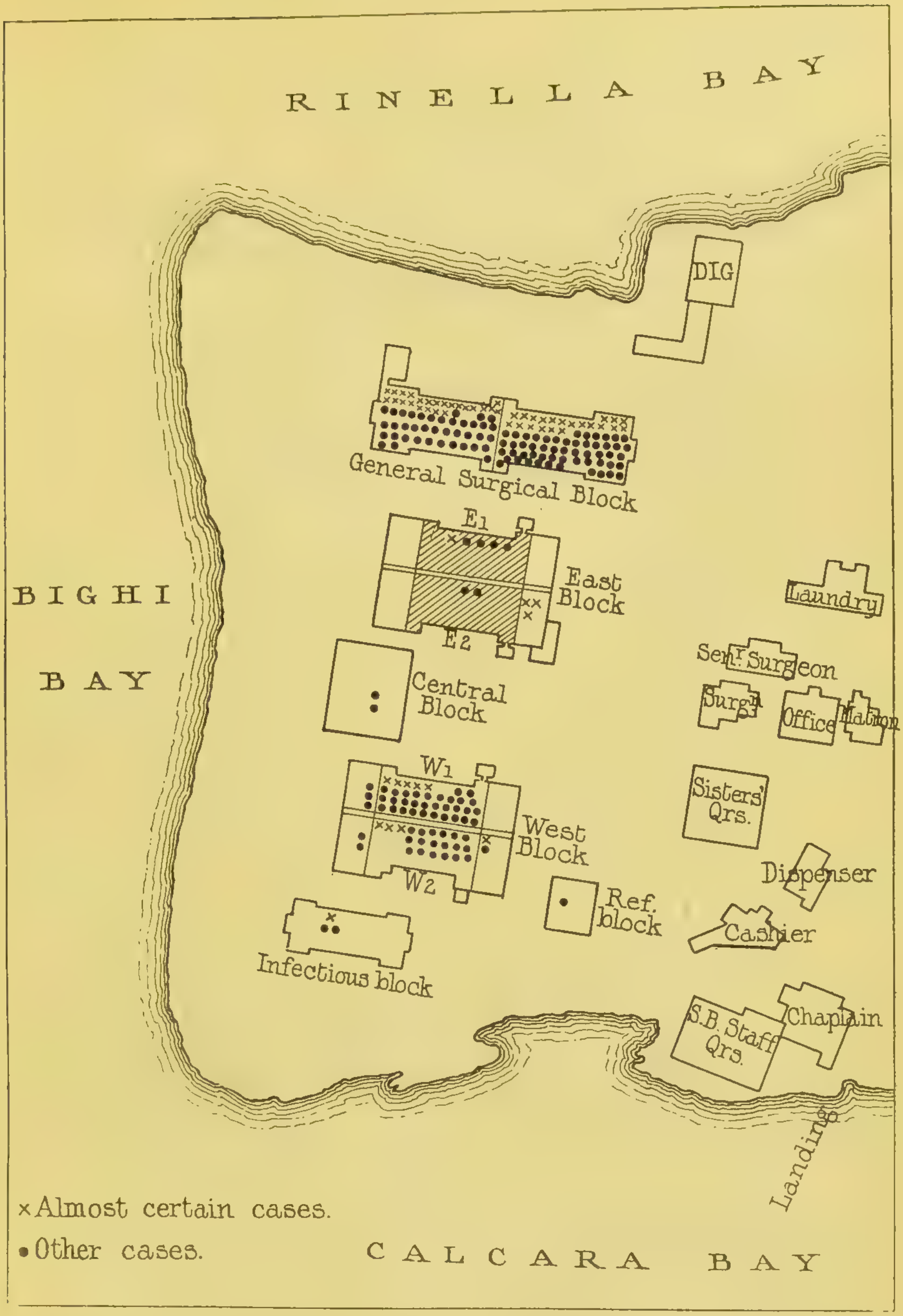


CHART 3.—*Period*—June, 1903, to June 22, 1905. *Conditions*—Fairly complete isolation. Mediterranean Fever cases in E 1 and E 2. Observation cases in medical wards W 1 and W 2. Surgical cases in Surgical Block. Mediterranean Fever wards shaded.

	Cases.	Approximate number exposed.		Cases.	Approximate number exposed.
In East Block.........	10	24*	In Infectious Block	3	32
In West Block	64	1057	In Central Block (scabies)	2	93
In Surgical Block ...	138	1571	In Refractory Block	1	24

* Entries since about January, 1904.

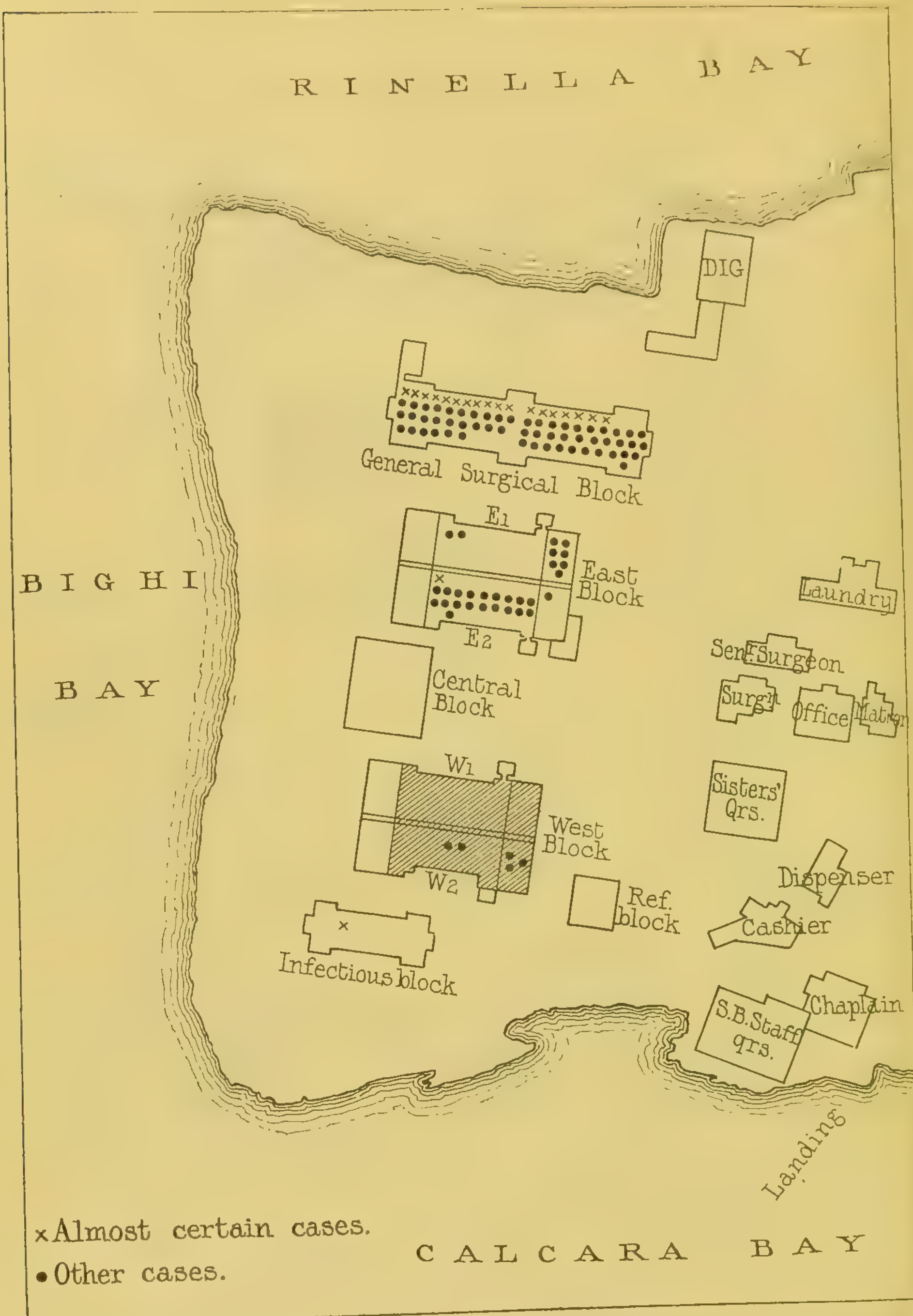


CHART 4.—*Period*—June 22, 1905, to April, 1906. *Conditions*—Complete isolation. Mediterranean Fever cases in W 1, W 2, and W 3. Observation cases in W 4. General medical cases in E 1 and E 2. Enteric cases in E 3. Mediterranean wards shaded.

	Cases.	Approximate number exposed.
In East Block	29	421
In West Block...............	5	?
In Surgical Block	74	814
In Infectious Block.........	1	3 ?

(To face page 33.)

Table V.—Showing the Localisation in Wards of Royal Naval Hospital according to the Month in which they were resident (1902—6) of :—A. Cases contracted while resident for other disease, or within 8 days of discharge (*in italics*). B. Cases developing Mediterranean Fever from 8 days to 3 months of discharge (in ordinary type).

Note.—These patients are entered for the final month of residence or, in the case of the disease being contracted while resident, for that month which falls 21 days before onset.

1902.

Ward.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
East Block —												
E 1	—	—	*4*	*1*	—	—	*2*	*1*	*2*	*1*	*2*	—
	—	1	6	7	3	2	3	1	—	2	6	—
E 2	—	*1*	—	*1*	*1*	—	*1*	—	—	—	—	*1*
	—	—	3	1	3	1	2	—	1	—	—	1
E 3 and 4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
West Block												
W 1	—	—	—	—	—	—	*1*	—	—	—	—	*1*
	1		3	2	—	2	—		—	1	—	—
W 2	No isolation till October, 1902. Mediterranean Fever in W 1 and 2									—	—	—
										1	1	—
W 4										—	—	—
										—	—	—
General (Surgical Block) —												
A	This Block not opened till about June 15, 1903											
B												
B 2												
C												
D												
E												
F												
Centre Block— Scabies	—	—	—	—	—	—	—	—	—	—	—	—
Zymotic	—	—	—	—	—	—	—	—	*1*	3*	—	—
	—	—	—	1	—	—	—	—	—	—	—	—
Refractory		—	—	—	—	—	—	—	—	—	—	—
Officers— Medical			1	—	1		—	—			—	—
Surgical	—	—		—	1	—	—	—	—	—	—	—
Total	1	2	17	13	9	5	9	2	4	8	9	3

1903.

Ward.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
East Block —												
E 1	*2*	*2*	*1*	*1*	*1*	—	Mediterranean Fever in E 1 and E 2 from June, 1903, until June, 1905					
	3	3	3	3	—	—						
E 2	—	—	—	—	—	*1*						
	3	—	2	3	2	—						
E 3 and 4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
West Block												
W 1	W 1 the Mediterranean Fever Ward till June, 1903. W 2 General Medical										—	—
											1	3
W 2	—	—	—	*3*	*1*	—	—	—	—	—	—	—
	6	3	2	4	2	—	1	1	2	—	—	—
W 4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
General (Surgical Block) —												
A	—	—	—	—	—	—	—	—	—	—	—	*1*
	—	—	—	—	—	—	—	—	—	—	—	—
B	—	—	—	—	—	—	—	—	—	—	—	*1*
	—	—	—	—	—	—	1	1	—	—	2	—
B 2	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
C	—	—	—	—	—	—	*1*	—	—	—	—	*1*
	—	—	—	—	—	—	—	2	—	—	1	—
D	—	—	—	—	—	—	*1*	—	—	—	—	—
	—	—	—	—	—	—	3	—	—	—	—	—
E	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	1
F	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	1	—
Centre Block— Scabies	—	—	—	—	—	—	—	—	—	—	—	—
Zymotic	—	—	—	—	—	—	—	—	—	—	—	—
	—	3	—	—	1	—	—	—	—	—	—	—
Refractory	—	—	—	—	—	—	—	—	—	—	1	—
Officers— Medical	1	—	2	—	—	—	—	—	—	—	—	—
Surgical	1	—	—	—	—	—	—	—	—	—	*1*	—
Total	16	11	10	14	7	1	7	4	2	—	7	7

1904.

Ward.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
East Block —												
E 1							—	*1?*	—	—	—	—
							—	—	—	2	—	1
E 2							—	—	—	—	—	—
							—	1	—	—	—	—
E 3 and 4	—	*1*	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
West Block												
W 1	—	—	—	*1*	—	*1*	*1*	—	—	—	—	—
	2	1	—	1	—	—	—	1	—	5	3	2
W 2	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	1	—	—	—	—	—	—	—	—
W 4	—	—	—	—	—	—	—	—	—	—	*1*	—
	—	—	—	—	—	1	—	—	—	—	—	—
General (Surgical Block) —												
A	—	—	—	—	—	—	—	*1*	—	—	*2*	—
	—	—	—	—	—	—	2	—	1	—	1	—
B	*2*	—	—	—	*1*	—	—	—	—	—	*2*	—
	3	1	—	—	—	1	1	—	—	1	3	2
B 2	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
C	*1*	*3*	—	*1*	—	—	—	—	—	*1*	*1*	*1*
	3	—	—	—	—	—	—	—	—	2	—	—
D	*2*	—	—	—	—	—	—	—	—	*1*	*2*	—
	1	1	—	—	1	—	1	—	—	5	1	—
E	*3*	—	*1*	—	—	—	—	—	—	—	—	—
	1	3	1	—	—	—	—	—	—	—	—	—
F	—	—	—	—	—	—	—	—	—	—	—	—
	1	—	—	1	—	—	—	—	—	—	—	1
Centre Block— Scabies	1	—	—	—	—	—	—	—	—	—	—	1
Zymotic	—	—	—	—	—	—	—	—	—	—	—	*1*
	—	—	—	1	—	—	—	—	—	—	—	—
Refractory	—	—	—	—	—	—	—	—	—	—	—	—
Officers— Medical	—	—	—	1	1	—	1	—	—	—	—	—
Surgical	—	—	—	—	—	—	—	—	—	—	*1*	—
Total	20	10	2	7	3	3	6	4	1	17	17	9

1905.

Ward.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
East Block —												
E 1	—	—	—	—	—	—	—†	—†	—	—	—	—
	—	1	—	—	—	—	—†	—†	—	1	1	—
E 2	—	—	—	—	—	—	—†	—†	—	—	—	—
	—	—	—	—	—	1	—†	—†	1	2	3	5
E 3 and 4	—	—	—	*2*	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	2	—	—	1	1	1
West Block												
W 1	*1*	—	—	—	*1*	—	Mediterranean Fever cases in W 1 and W 2 after June 22, 1905. W 3 and W 4 used as Observation Wards					
	—	—	3	6	1	2						
W 2	—	—	—	—	*3*	—	—	—	—	—	—	—
	—	—	—	—	13	—	—	—	2	—	—	—
W 4	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	2	—
General (Surgical Block) —												
A	—	—	—	—	*2*	—	—	—	*2*	*1*	—	*1*
	—	1	—	1	3	—	—	—	1	—	1	1
B	—	—	—	—	*1*	—	—	—	—	*1*	—	—
	—	—	—	2	5	1	—	—	1	1	2	—
B 2	—	—	—	—	—	—	—	—	—	—	—	*1*
	—	—	—	—	—	—	—	—	1	—	—	—
C	—	—	—	*1*	*1*	*1*	—	—	*1*	—	—	—
	—	1	—	1	5	1	1	—	—	—	—	—
D	—	*1*	*1*	—	*6*	—	—	—	—	*1*	—	—
	—	1	—	1	4	1	—	—	2	1	2	1
E	—	—	—	—	—	—	*1*	—	—	—	—	—
	—	—	—	2	3	—	—	—	—	—	1	2
F	—	—	—	—	—	—	—‡	—	—	—	*1*	*1*
	3	1	—	—	—	2	—‡	1	—	1	1	1
Centre Block— Scabies	—	—	—	—	—	—	—	—	—	—	—	—
Zymotic	—	—	—	—	—	—	*1*	—	—	—	—	—
	—	—	1	—	—	—	—	—	—	—	—	—
Refractory	—	—	—	—	—	—	—	—	—	—	—	—
Officers— Medical	—	—	—	2	—	—	—	—	—	—	—	—
Surgical	—	—	—	1	1	1	—	—	—	1	—	—
Total	4	6	5	19	49	10	5	1	11	11	15	14

1906.

Ward.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
East Block —												
E 1	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
E 2	—	*1*	—	—	—	—	—	—	—	—	—	—
	6	1	1	—	—	—	—	—	—	—	—	—
E 3 and 4	—	—	—	—	—	—	—	—	—	—	—	—
	1	1	—	—	—	—	—	—	—	—	—	—
West Block												
W 1												
W 2	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
W 4	—	—	—	—	—	—	—	—	—	—	—	—
	1	—	—	—	—	—	—	—	—	—	—	—
General (Surgical Block) —												
A	—	*3*	—	*1*	—	—	—	—	—	—	—	—
	3	2	2	—	—	—	—	—	—	—	—	—
B	—	*1*	*1*	—	—	—	—	—	—	—	—	—
	2	4	—	—	—	—	—	—	—	—	—	—
B 2	—	—	—	—	—	—	—	—	—	—	—	—
	1	—	—	—	—	—	—	—	—	—	—	—
C	—	—	—	—	—	—	—	—	—	—	—	—
	2	1	—	—	—	—	—	—	—	—	—	—
D	—	—	—	—	—	—	—	—	—	—	—	—
	3	2	—	—	—	—	—	—	—	—	—	—
E	—	—	—	—	—	—	—	—	—	—	—	—
	1	3	1	—	—	—	—	—	—	—	—	—
F	—	—	—	—	—	—	—	—	—	—	—	—
	2	2	—	—	—	—	—	—	—	—	—	—
Centre Block— Scabies	—	—	—	—	—	—	—	—	—	—	—	—
Zymotic	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	—
Refractory	—	—	—	—	—	—	—	—	—	—	—	—
Officers— Medical	—	—	—	—	—	—	—	—	—	—	—	—
Surgical	1	—	1	—	—	—	—	—	—	—	—	—
Total	23	21	6	1	—	—	—	—	—	—	—	—

Grand total............ 468 + 3 in 1901 = 471.

* Enterics.

† In process of disinfection.

‡ General Medical June 20 to August 21, 1905.

fact, in the majority of instances, an increase in the number contracted in hospital during any particular month appears to precede the months during which the largest average number of cases are under treatment, and probably is, to some extent, accountable for it.

As might have been expected, more cases appear to follow a high admission rate for diseases other than Mediterranean Fever, or, in other words, the amount of the latter disease contracted in hospital depends, to some extent, on the quantity of susceptible material exposed. The majority of cases are seen to occur in the winter when the hospital is most full, but there are occasional rises in the curve entirely independent of any recognisable factor.

Relation to Total Number of Cases of all Sorts under Treatment in Hospital and to Season.—Table VI, p. 34, compares the ratio of the number of Mediterranean Fever to other cases, and the ratio of the number of these latter subsequently developing fever to the total number exposed, and once more demonstrates an entire absence of any correspondence. Incidentally it shows that the rate is higher as a rule with a large total number of all cases under treatment, and lower when this is small, and that, therefore, the winter rate is usually higher than the summer, but that this rule is belied by occasional outbreaks which do not appear to depend upon season or the amount of infective material. Yet another argument against mosquito infection is therefore provided by Table VI.

Meteorological Conditions.—The daily temperature, rainfall, and direction and force of wind during 1905 and 1906 have been studied in relation to the occurrence of cases, but nothing can be discovered which appears to have any bearing on the exceptional prevalence at certain times, such as May, 1905, and January and February, 1906. At the former date the temperature was high and rising, and the weather very dry, at the latter the temperature was extremely low, and there was heavy rain. There was much wind at both seasons, but the force was perhaps greater in the two winter months. The wind which would most favour the convection of particles of dust or biting flies from the Mediterranean Wards to the Surgical Block would be any southerly wind in May, when the East was the Mediterranean Block, whereas in January and February, with the West as the Mediterranean Block as at present, a south-west wind is practically the only one which would produce much effect in this way, and the buildings are, in addition, screened from one another.

In May, north-west, south, and south-east were the prevalent winds, and the direction was southerly on 16 days.

In January, south-west, south-east, and east were the prevalent winds, and the direction was south-west on seven days.

In February the prevailing winds were north-east, south-west, west, and north-east, south-westerly on eight days.

Table VI.—Showing, for each quarter since January, 1902, the total number of cases of all sorts under treatment, the proportion of Mediterranean Fever cases and of cases of other illness, and comparing the ratio of Mediterranean Fever cases to those of other illness in residence during each quarter with the proportion of cases of other illness who are known to have subsequently developed Mediterranean Fever.

Year …………	1902.				1903.				1904.				1905.				1906.			
Quarter…………	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th	1st	2nd	3rd	4th
Total number of cases under treatment	563	605	431	486	498	518	383	611	603	526	443	532	605	605	452	584	476	368	—	—
Of which were Mediterranean Fever	65	129	71	81	93	119	97	101	112	95	53	82	73	130	87	54	75	75	—	—
Total cases other than Mediterranean Fever	498	476	360	405	405	399	286	510	491	431	390	450	532	475	365	530	401	293	—	—
Of which are known to have subsequently developed Mediterranean Fever	20	27	15	20	37	22	13	14	32	13	11	43	15	78	17	40	50	1*	—	—
Ratio of Mediterranean Fever cases to total under treatment	p. c. 11·5	p. c. 21·0	p. c. 16·4	p. c. 16·6	p. c. 18·6	p. c. 22·9	p. c. 25·3	p. c. 16·5	p. c. 18·5	p. c. 18·0	p. c. 11·9	p. c. 15·4	p. c. 12·0	p. c. 21·6	p. c. 19·2	p. c. 9·2	p. c. 15·7	p. c. 20·3	p. c. —	p. c. —
Ratio of cases of other illness who developed Mediterranean Fever subsequently	4·0	5·6	4·1	4·9	9·1	5·5	4·5	2·7	6·5	3·0	2·8	9·5	2·8	16·4	4·6	7·5	12·4	0·3	0	0

* This man was discharged on April 16 and became ill on April 19.

NOTE.—Cases subsequently developing Mediterranean Fever, and who are resident for more than one quarter, are entered for the quarter in which the disease was apparently contracted, or in which discharge from hospital occurred, where onset was subsequent to such discharge.

To that extent, therefore, the conditions may be said to have been favourable for dust or insect convection, but the subject is discussed elsewhere in more detail.

Relationship to Type of Disease for which the Patient was originally under Treatment.—Table VII gives the ratio of incidence in the various diseases for which the patients were under treatment. This once more brings out the fact that the distribution is very general, but that certain types suffer far more severely than others. Among those for which any large number were admitted it will be noticed that catarrh, simple continued fever, and influenza show a comparatively low ratio, whereas the opposite is the case with enteric fever, the initial stages of venereal disease, nervous and ear affections, pneumonia and pleurisy, practically all ailments affecting the digestive tract and the genito-urinary system, abscess, and injuries. There is a remarkable immunity in the case of tubercular disease, which may be due to the fact that such patients are invariably invalided and thus lost sight of, although an antagonism between the two is possible, especially in view of the results of experiments this year.

If, now, Table VIII, giving the proportion attacked in 1905 and 1906, according to duration of residence, is examined, it is first seen that a very large majority of attacks of Mediterranean Fever occur among patients who have been in hospital for prolonged periods, and, secondly, that diseases in which incidence is low are mainly those of short duration, while those in which incidence is high provide the greater part of the prolonged residence cases. In other words, prolonged residence would appear to explain the special liability of venereal and other surgical cases to attack, and, at least, may be said to be more important than any other condition yet discussed. This is the probable explanation of the special incidence in surgical wards. An interesting point in these two tables is the comparatively high incidence in sore throat and tonsillitis, which would provide a portal of entry for anything ingested in the mouth, as compared with other diseases of short duration. Indeed, there seems to be a specially heavy ratio among digestive diseases generally.

Direct Evidence with regard to Mosquitoes.—From the description of the water supply, the exceptional opportunities existing in Bighi for breeding of mosquitoes can be readily understood, and their prevalence is quite in accordance with anticipation. Surveys in and around the hospital were made on several occasions, and the following gives a brief summary of the result :—

The foreshore around Bighi itself is singularly free from larvæ-containing pools, and numerous examinations showed none. The same applies to the northern shore and head of Rinella Bay, and, owing to the fact that Calcara Bay has been so largely altered and made use of for wharves, landing-places, etc., very few can be found there either.

Table VII.—Showing Number of Cases admitted each year from January, 1902, to end of First Quarter of 1906, which were under Treatment in the Royal Naval Hospital, and the number of these which are known to have developed Mediterranean Fever later.

	1902.		1903.		1904.		1905.		First quarter, 1906.		Total.			Cases almost certainly contracted in hospital. Number who contracted Mediterranean Fever.
	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Percentage.	
Eruptive fevers, etc.	11	1	21	2	16	2	3	2	—	—	51	7	13·7	1
Other contagious general disease	1	—	13	—	8	—	4	1	—	—	26	1	3·8	1
Influenza	36	1	55	6	51	2	62	1	17	1	221	11	5·0	—
Fever, S. C.	23	—	22	1	47	3	28	2	1	—	121	6	5·0	—
Enteric	51	7	17	1	48	—	36	9	3	1	155	18	11·6	6
Septicæmia	2	—	—	—	—	—	—	—	—	—	2	—	—	—
Dysentery	7	2	4	1	2	—	2	—	—	—	15	3	20·0	—
Ague	2	—	1	—	10	—	1	—	1	—	15	—	—	—
Erysipelas	2	—	4	1	—	—	2	—	—	—	8	1	12·5	—
Tubercle	75	—	63	—	42	2	30	—	5	—	215	2	0·9	1
Chancroid	—	—	—	—	—	—	61	9	21	6	82	15	18·3	8
Syphilis, Pr.	65	5	99	5	72	11	57	10	1	1	294	32	10·8	10
" Sec.	88	2	90	2	105	5	88	7	21	2	392	18	4·5	3
Gonorrhœa	57	9	76	7	99	3	100	15	14	1	346	35	10·1	9
Seg. Gon.	8	—	17	1	38	—	47	6	3	—	113	7	6·2	2
Scabies	40	2	15	3	42	1	63	—	14	—	174	6	3·4	1
Other parasitic disease	2	—	—	—	3	—	1	—	—	—	6	—	—	—

Plumbism and other poisons	1	—	1	—	3	—	10	*4*	1	—	16	*4*	25·0	—
Alcoholism	5	—	4	—	3	—	—	—	—	—	12	—	—	—
Rheumatism	55	*2*	32	*2*	44	*3*	32	*7*	7	*1*	170	*15*	8·8	—
New growth, non-malignant	6	*1*	16	*1*	20	*2*	25	*4*	—	—	67	*8*	12·0	—
,, malignant	—	—	1	—	4	—	3	—	—	—	8	—	—	—
Diabetes and other general disease	1	—	1	—	6	—	3	*1*	—	—	11	*1*	9·0	—
Disease of spinal cord	2	—	1	—	—	—	2	—	—	—	5	—	—	—
,, brain	2	—	2	—	3	—	4	—	—	—	11	—	—	—
Apoplexy	—	—	1	—	—	—	—	—	—	—	1	—	—	—
Paralysis	3	—	—	—	2	—	4	—	—	—	9	—	—	—
Epilepsy	11	—	8	—	6	*1*	6	*2*	2	—	33	*3*	9·0	—
Vertigo	—	—	—	—	1	—	2	—	2	*1*	5	*1*	20·0	—
Neuralgia	—	—	4	*1*	3	—	1	*1*	—	—	8	*2*	25·0	1
Other nervous disease	32	*3*	20	*2*	18	*1*	18	*3*	4	—	92	*9*	9·7	—
Insanity	17	—	14	—	12	*1*	—	—	2	—	45	1	2·2	—
Disease of eye	30	—	26	—	22	*1*	28	*1*	4	*1*	110	*3*	2·7	1
,, ears	23	—	14	*2*	16	*4*	23	*2*	3	*1*	79	*9*	11·4	3
,, nose	3	—	—	—	—	—	2	—	2	—	7	—	—	—
Heart disease, organic	31	—	8	*1*	12	—	14	*1*	2	—	67	*2*	3·0	1
,, functional	9	—	7	—	19	—	5	—	—	—	40	—	—	—
Aneurysm	2	—	—	—	—	—	2	—	2	—	6	—	—	—
Disease of veins	5	*1*	6	—	15	—	14	*1*	—	—	40	*2*	5·0	1
Other disease of circulatory system	—	—	1	—	2	*1*	—	—	—	—	3	*1*	33·3	1
Disease of larynx	1	—	2	—	1	—	1	*1*	—	—	5	*1*	20·0	1
Catarrh	61	*2*	42	*3*	30	—	90	*7*	9	*1*	233	*13*	5·6	—
Bronchitis	12	—	12	—	9	*1*	16	*2*	2	*1*	51	*4*	7·8	2
Hæmoptysis	1	—	3	—	4	—	—	—	—	—	8	—	—	—
Pneumonia	21	—	15	*1*	20	*1*	20	*5*	1	—	77	*7*	9·0	2
Phthisis	3	—	1	—	2	—	20	*1*	1	—	27	*1*	3·7	1
Pleurisy	11	*2*	22	*3*	21	—	15	*1*	3	—	72	*6*	8·3	1
Asthma	1	—	3	—	4	*1*	5	—	1	—	14	*1*	7·1	—
Other respiratory disease	2	—	—	—	—	—	—	—	—	—	2	—	—	—
Mouth, teeth, etc.	1	—	1	—	1	—	5	—	3	—	11	—	—	—
Sore throat, tonsillitis	35	—	34	*5*	40	*2*	59	*7*	12	*1*	180	*15*	8·3	1
Disease of stomach	5	—	17	—	18	*1*	10	—	—	—	50	*1*	2·0	—
,, intestines	30	*4*	29	*5*	31	*4*	40	*7*	1	—	131	*20*	15·2	3
Hernia	24	*4*	13	*2*	18	*2*	24	*7*	4	—	83	*15*	18·0	8
Hæmorrhoids	18	*5*	10	*1*	20	*3*	26	*5*	3	*2*	77	*16*	20·0	4
Fistula	4	—	7	*1*	2	—	2	*1*	1	—	16	*2*	12·5	—
Hepatitis	5	—	1	*1*	1	—	—	—	—	—	7	*1*	14·2	—
Other disease of liver	6	—	5	—	18	*3*	14	—	5	—	48	*3*	6·2	1

Table VII—*continued.*

	1902.		1903.		1904.		1905.		First quarter, 1906.		Total.			Cases almost certainly contracted in hospital. Number who contracted Mediterranean Fever.
	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Number of persons exposed.	Number who contracted Mediterranean Fever.	Percentage.	
Disease of rectum	4	*1*	5	—	1	*1*	12	—	—	—	22	*2*	9 ·0	1
Bubo, non-venereal	14	*2*	10	—	3	*3*	15	*2*	7	—	49	*7*	14 ·2	2
Other lymphatic disease	9	*1*	4	—	2	—	9	*4*	1	—	25	*5*	20 ·0	—
Disease of kidneys	12	—	9	*1*	17	—	14	*2*	—	—	52	*3*	5 ·7	1
" bladder	5	—	3	*1*	1	—	2	*1*	—	—	11	*2*	18 ·1	—
Stricture	15	—	6	—	8	*1*	8	—	2	—	39	*1*	2 ·5	—
Varicocele	3	—	5	*2*	7	—	8	*2*	—	—	23	*4*	17 ·4	—
Orchitis	4	—	3	*1*	—	—	2	*1*	—	—	9	*2*	22 ·2	—
Other genito-urinary disease	9	—	13	—	16	*3*	22	*2*	3	*1*	63	*6*	9 ·5	—
Disease of bones	4	—	10	*1*	11	—	8	*2*	—	—	33	*3*	9 ·0	1
" joints	10	*2*	8	*1*	14	—	11	*1*	—	—	43	*4*	9 ·3	—
" spine	—	—	—	—	—	—	1	—	—	—	1	—	—	—
" bursæ	6	*1*	7	*2*	7	*2*	8	*1*	2	—	30	*6*	20 ·0	1
Other locomotory disease	—	—	1	—	—	—	—	—	—	—	1	—	—	—
Abscess	53	*8*	33	*5*	36	*4*	38	*4*	11	—	171	*21*	12 ·3	7
Ulcer	33	*2*	8	*1*	15	—	21	*1*	3	*1*	80	*5*	6 ·2	1
Boil and other skin disease	21	*2*	31	—	18	*1*	34	*3*	5	*1*	109	*7*	6 ·4	2
Injuries	133	*24*	119	*9*	155	*10*	135	*11*	48	*4*	590	*58*	9 ·8	23
Undetermined	—	—	2	—	—	—	2	—	1	—	4	—	—	—
Total	1284	*96*	1158	*85*	1345	*86*	1480	*170*	261	*28*	5528	*465*	8 ·4	113

TABLE VIII.—Showing the Duration of Residence in Cases admitted each Quarter from January, 1905, to September, 1906, and giving the proportion in each case who are known to have subsequently, either during or within three months of residence, developed Mediterranean Fever.

Year. Duration of residence.	1906 (first quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	74	2	103	1	78	5	44	6	107	20

Year. Duration of residence.	1905 (second quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	75	11	101	9	76	14	49	8	60	18

Year. Duration of residence.	1905 (third quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	53	1	74	3	64	2	34	4	72	10

Year. Duration of residence.	1905 (fourth quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	56	4	106	7	69	8	75	8	129	29

Year. Duration of residence.	1906 (first quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	37	2	86	9	47	4	39	5	52	8

Year. Duration of residence.	1906 (second quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	33	—	76	—	45	—	39	—	53	—

Year. Duration of residence.	1906 (third quarter). Under 10 days. No. exposed.	Cases.	10 to 20 days. No. exposed.	Cases.	20 to 30 days. No. exposed.	Cases.	30 to 40 days. No. exposed.	Cases.	Over 40 days. No. exposed.	Cases.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	35	—	25	—	28	—	15	—	35	—

The nearest point at which larvæ were found on the foreshore was on the northern side of the Breakwater and around the seaward face of Ricasoli, a point at least 500 yards from the nearest portion of the hospital grounds. They were found also in large numbers at the naval range at Ricasoli, and when bred out proved to be *Acartomyia Zammittii.*

The greater number of the underground tanks are situated in the residential area of the grounds, and here, also, the garden tanks, tubs, etc., are most numerous. Three of the underground tanks close to the Office Block were at one time or another found to be swarming with larvæ, which on being bred out proved to be either *Culex fatigans*, *pipiens*, or *spathipalpis*. In one or two more, one near the hospital proper, adult mosquitoes issued on opening, or cast larvæ cases were found, but larvæ were never numerous enough to be detected. The same three varieties of Culex were also bred out from some of the gullies and garden tanks, but none were ever found on any of the roof tanks.

The adult insects were also sent over for some months for identification. Of 156 examined, 75 proved to be *C. pipiens*, 56 *C. fatigans*, 22 *Stegomyia fasciata*, and 3 *Acartomyia*, the proportions thus corresponding very closely to those of Kennedy and Horrocks last year, and the small number of *Acartomyia* bearing out the observations made with regard to their breeding places. The first two were most prevalent in the early part of the year, Stegomyia in the latter part of August and September.

Since November 13, 1905, systematic oiling of all water traps and exposed tanks has been carried out in Bighi every Friday with, it is said, good results, although mosquitoes are still very numerous. In addition, all flushing tanks and exposed water tanks have been fitted with covers.

To exterminate them, however, in a place with such innumerable and inaccessible breeding places is a matter requiring a large staff in itself and constant supervision, and the hospital gardener and his assistants can hardly be expected to accomplish it.

Large square mosquito nets were fitted in the Mediterranean Fever wards at the end of June, 1905, and small ones in A and B Wards, and since October, 13, 1905, other wards have been gradually supplied.

Although these nets cannot be said to constitute a very efficient protection unless carefully looked after by the user, a very doubtful matter with the bluejacket, they must be regarded when fitted in the fever wards as not only protecting the patient to some extent from mosquito attack, but as preventing a certain proportion of infected mosquitoes, when full of blood and therefore sluggish, from escaping to be a possible danger to others. Accordingly one would expect some diminution as the result of their use, and the absence of such constitutes one more bit of evidence against this method of dissemination.

Direct Evidence with regard to Milk Infection. The Milk Supply at Bighi.—Goat's milk has always been the source of supply, and there has for a long time been a standing order that it should be boiled before issue to the patients, an order that was repeated in July, 1905. The goats were brought daily to the main gate of the hospital, being milked in summer just outside in a rather windy and dusty square, and in the winter inside a neighbouring dairy shed. The milk was collected in 10- and 24-pint cans, the former, according to the goatherd, holding on the average the milk of four animals and the latter of eight to ten. In these it was conveyed three times daily, at 5.30 and 9.15 a.m., and 1 p.m., to the hospital kitchen for the patients and to the various quarters for the staff, sterilisation being presumably effected in each separate place.

In the kitchen the apparatus in use consisted of three copper pans, in which the milk was heated until about 98° C., this taking about 50 minutes on each occasion, and necessitating continued stirring.

To facilitate rapid heating, instead of emptying a can bodily into one copper pan, a little was added to each of the three. It was subsequently conveyed to the wards in other special receptacles.

This method was so obviously imperfect that an Aymard steriliser had some time ago been applied for and approved, but up to the end of March it had not been fitted.

From the above facts it is evident that the milk must have undergone considerable dilution before issue. It is evident, too, that with Maltese cooks, possessed of profound faith in the virtues of goats' milk, we cannot feel certain that effective sterilisation had been carried out when the total number of cases in hospital was great and the work of boiling correspondingly heavy.

Evidence that the Milk was Infective.—Shaw first examined the goats supplying the hospital in July, 1905, and found that out of 91 goats 30 presented an agglutination reaction, and the milk of 9 yielded the *Micrococcus melitensis*. The organism was proved to be infective for monkeys. In March, 1906, the goats were again examined by Whiteside, and, out of 78, an agglutination reaction was presented by 21, and 5 of these presented Micrococcus. On July 3, 1906, the herd was once more examined by Zammit, and, out of 46, 7 were found to react. For reasons given subsequently, the examination was not persisted in.

Evidence of Ineffective Sterilisation.—As will be seen on p. 71, Whiteside has established, beyond the possibility of doubt, that occasionally, at least previously to April 8, 1906, sterilisation was not properly carried out in the kitchen. It follows that milk cannot be eliminated as a possible vehicle of infection in any case before that date.

The ingestion by a patient in any particular part of the hospital of a dose of infective milk would, to a large extent, therefore depend

upon a combination of factors. The presence of goats in the herd who were excreting *Micrococcus melitensis* may be assumed, from the examinations, to be practically constant.

From the method of collection it is evident that, as a rule, the milk must have been greatly diluted, but that at any time chance may have decreed that one can or one sterilising pan should have contained the milk of a large proportion of infected goats, and thus produced a much more highly infective dose than usual.

A third factor would be the varying efficiency of sterilisation.

In addition to these we have to consider the individual susceptibility of the persons drinking it. Whatever may be the reason, whether it depends on the presence of mouth lesions or not, there can be no question that individual susceptibility to this method of infection, if accepted as a method, must vary, since at the time of Whiteside's observation numerous men, who have not since suffered, drank the milk which was proved to have been infective.

Duration of residence, therefore, by favouring the combination of these factors, and the presence of a large number of patients in hospital, by increasing the chances of ineffective sterilisation, may be regarded as circumstances which would favour the possibility of milk infection.

Evidence of Milk Drinking.—Of the 471 cases under consideration no notes are available in the case of 14, but in at least eight of these the disease from which they were suffering afforded a practical guarantee that they would be on milk diet, and in the rest it is probable. Of the remaining 457 no milk is noted on the case sheets of six, while the remainder all had it in varying quantities. One of these six cases was almost certainly contracted in hospital and developed the disease while resident there. One, however (the only patient among the 471 resident for so short a time), was only in hospital three days, and the chances are against his having contracted it there. The disease from which they suffered was: Syphilis primary in three cases, gonorrhœa in one, fracture in one, and new growth in one :—

Table IX.—Showing the Total Amount of Milk Ingested.

Amount in pints	Under 5.	6 to 10.	11 to 20.	21 to 30.	41 to 60.	Over 60.
No. of patients	20	19	50	106	81	175

The vast majority are seen to have had a considerable amount, and there is almost a progressive rise in the numbers to the larger

quantities. This is brought out distinctly in the next table giving the number of days on milk, an even more important point to investigate, taking into consideration the probable intermittency both of sterilisation and the supply of infected milk:—

Table X.—Showing the Number of Days on Milk.

Days ...	1.	2 to 5.	6 to 10.	11 to 20.	21 to 30.	Over 30.
No. of patients	19	31	56	88	81	177

Table XI.—Giving the Interval between the last Issue of Milk and the Onset of Symptoms of Mediterranean Fever.

Interval in weeks	None.	Under 1.	Under 2.	Under 3.	Under 4.	Under 5.	Under 6.	Under 7.	Under 8.	Over 8.
No. of patients	74	16	25	20	42	46	33	46	26	123

Naturally the cases which had been discharged for some time provide the majority of long intervals, and, equally naturally, those contracted while resident give practically all instances of no interval.

It is interesting, therefore, to give the intervals exceeding three weeks in those with onset while resident, within eight days of discharge, and from nine days to a month of discharge respectively:—

Table XII.—Showing the Intervals exceeding Three Weeks in Cases giving the greatest Probability of Infection in Hospital.

Interval in weeks......	Under 4.	Under 5.	Under 6.	Under 7.	Under 8.	Over 8.
While resident	4	3	2	—	1	1
Within 8 days	—	2	2	1	—	1
From 9 days to 1 month	39	22	7	9	4	7

This shows clearly that if milk is to be accepted as the vehicle of infection in these cases—and it is difficult to avoid this conclusion when the results of effective sterilisation, as detailed on p. 74, are taken into consideration—the prevailing ideas with regard to the duration of the incubation period, considered as the interval between ingestion of

the infective milk and the onset of definite symptoms, will have to be considerably modified.

There would be nothing in the experimental work yet done to negative this view, as the interval is consistently shown to be lengthened in this mode of infection as compared with inoculation.

An interesting point is brought out in this investigation with regard to patients suffering from Scabies, who are not usually given milk. The circumstances were examined into in eight of these, although only six were included in Table I, as one was only 17 days in hospital before developing symptoms and another had been discharged for more than three months. All, however, without exception, had had milk, four only for a short time, but the remainder for a considerable time. It would, therefore, appear that the Scabies cases which eventually develop Mediterranean Fever are picked out from the very small proportion who are given milk.

Control.—Staff-Surgeon Richards kindly provided a list of the patients in his wards in the early part of 1906, with the particulars shown in Table XIII:—

Table XIII.—Giving the Milk History of a Series of Cases in the Venereal Wards.

	No milk.	Very little milk.	Fair amount.	Large amount.
Cases not developing Mediterranean Fever	20	23	50	34
Cases developing Mediterranean Fever......	1*	1	16	14

* This man, a S.B. attendant in hospital, admitted having drunk half a pint of unsterilised milk in his own quarters daily.

Although this evidence is on the whole in favour of milk, it shows once more that the individual must be taken into account, as some men from the dates given must have been taking the same milk and for as long a time as those who developed the disease. This, however, is in accordance with experimental evidence.

In the next table is shown for each ward during the year 1905 taken as a whole :—

(1) The total amount of milk consumed.

(2) The average consumption per head.

(3) The ratio of patients in the different blocks who subsequently developed fever to the total number of diets issued. By working out this ratio the duration of residence which has been shown to be of such importance is eliminated as a factor, inasmuch as the cases are regarded collectively rather than individually.

Table XIV.

Ward.	Description of use.	Days in use.	Total milk in pints.	Average per head, daily.	Total number of diets issued.	Cases of Mediterranean Fever.	Ratio of cases to daily victuallings.
							per cent.
W 1	General medical to June	144	7708	2·0	3741	14	0·61
W 2		120	3180	2·1	1468	18	
E 1	General medical after August	49	783	1·8	417	3	0·44
E 2		132	6674	2·4	2800	12	
E 4	Enteric	335	5017	2·9	1732	7	
A	Venereal	295	5733	1·0	5302	14	0·30
B	,,	347	8597	1·1	7406	16	
C	Operation	365	6520	1·4	4632	13	
D	Septic cases	354	7791	1·5	5204	22	
E	General medical, June 20—Aug. 21	170	3103	1·6	1913	9	
F		237	5022	1·4	3424	12	
	Zymotic	261	715	2·1	261	2	0·76
	Officers, surgical	258	1758	2·4	729	4	0·54

Quite a decided correspondence is here shown between this ratio and the average consumption per head, and the fact that the ratio in the medical wards, when taken in this way, is higher than that in the surgical constitutes a further bit of evidence in favour of the view that it is duration of residence which is the chief factor in production of the high incidence in the latter.

(b) *Mediterranean Fever occurring among the Sick Berth Staff.*

The heavy incidence among hospital attendants in Malta has long been a matter of common observation, and no investigation of the prevalence of the disease in hospital would be complete without taking into account this particular section of men. As great a number of cases as possible have been enquired into, but only since 1901, as in previous years the agglutination reaction was not established as a routine method of diagnosis.

*Proportion Affected.**—From January 1, 1902, to June 16, 1906, including 20 men who were already serving on the former date, 171 separate individuals have been borne on the staff at Bighi, and of those 80 are known to have contracted the disease, while three more of the 20 already serving had had it in previous years. About 47·6 per cent. therefore have at some period or other during their residence fallen victims to it.

* About half a dozen men who were under two months on the staff and were not attacked have not been included.

Average Duration of Residence Previous to Contraction.—The shortest period recorded is one of 25 days, and in this case the patient had contracted gonorrhœa in Malta, and was under treatment for that affection when his symptoms appeared. See p. 69, Case 5.

In five the onset was under two months, and in seven under three, a total of 13 within that time; 17 occurred between the third and sixth month, and two between six months and a year; 22 more contracted it during their second year, and six during their third.

Taking into consideration the manner in which new arrivals are victimised by mosquitoes, this comparatively lengthy period is not altogether compatible with the theory of dissemination by biting flies, and it has been thought worth while to see if the men joining in the hot weather are attacked earlier than those joining in the winter. Of 38 attacked, therefore, who arrived between April and September, the duration of residence in seven was under three months, and in eight between three and six, while of 41 joining during the winter period the figures were seven and nine respectively. The case with only 25 days joined in Msrch.

Table XV.—Showing the Proportion in which various Ratings are affected.

Rating	Ch. S.B. stds.	S.B. stds.	2nd S.B. stds.	S.B. attendants.
Total exposed	7	12	24	127
Contracted fever ...	4	5	8	61
Percentage	57	42	33	48

Three of the attendants are known to have been protected by previous attack.

These figures show quite as great a liability among those not in actual attendance on the sick as among the nursing section.

Relationship of Attacks to Duties.—Table XVI shows the duty upon which the patient was engaged immediately or closely preceding the onset of the attack in the cases occurring during each of the four periods into which the time under consideration has previously been divided. See p. 46.

Table XVI.—Giving the immediate Duty engaged upon, as compared with the Average Number employed, among the 80 S.B. Staff who suffered from Mediterranean Fever since January, 1901. One ambulatory case omitted.

Period I.—No isolation. January, 1901—October, 1902.

Ward or duty employed in or upon.	Employment of ward.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	4	7	
East I and II ... East III and IV	Surgical cases	3	5·4	
West I	Medical, including Mediterranean Fever cases	5	4·3	Of these—1 was only employed 14 days and 1 was only employed 9 days. In East Block previously. 1 was only employed 9 dys. and in zymotic previously; 1 was only employed 7 dys. and previously with officers; 2 others were on night duty
West II.........		2		
West IV		—		
Surgical Block ...	Not opened yet			
Zymotic Block ...	—	1	—	Night watch for 19 days. W 2 for 7 days previously
Night patrol	—	1	—	This was succeeded by rheumatism for a month. Then worked in officers' cabins for a month and was sick June 5, 1902, with neuritis, both sciatics
Mess kitchen......	—	1		
Ch. S.B. stewards	—	3		
Total	—	20		

Table XVI—*continued.*

Period II.—Almost complete isolation. October, 1902—June, 1903.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	2	6·5	
East I and II ... East III and IV	Surgical cases	3	7	
West I	Mediterranean Fever	1	4	
West II......... West IV	General medical and observation Tubercle	—	3·6	
Surgical Block ...	Not opened yet			
Zymotic Block ...	—	1	—	G. D. for 5 days immediately preceding sick list. Night duty in zymotic
Mess kitchen......	—	1		
General duties ...	—	1	—	For 11 days. Night watch in E 1 previously
Total	—	9		

Table XVI—*continued.*

Period III.—Almost complete isolation. June, 1903—June 22, 1905.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	6	6	1 of these for 9 days only. General duty previously. 1 on sick list just previously
East I and II ...	Mediterranean Fever wards	4	7·3	
East III and IV	Enteric ward	2		
West I	General medical and observation wards	1	6	Zymotic subsequently for for 21 days preceding relapse
West II.........		1		
Surgical Block ...	Surgical. Opened June 15, 1903	7	12·5	
Zymotic Block ...	—	1	—	Zymotic for 20 days. Previously on list with dyspepsia
Laboratory	—	2		
Night patrol......	—	2	—	1 had just been sick with epididymitis
Mess kitchen......	—	1	—	For 11 days only. The surgical side previously
General duties ...	—	2	—	1 for 9 days. Night watch west wing previously
Ch. S.B. stewards	—	1		
Refractory Block	—	1	—	For 12 day only. In zymotic previously
Total	—	31		

Table XVI—*continued.*

Period IV.—Complete isolation.

Ward or duty employed in or upon.	Employment of wards.	Cases among staff.	Average number employed.	Remarks.
Officers	Medical and surgical cases	3	4	1 surgical side, 2 medical side
East I and II ...	General medical wards	2	6·4	1 night duty
East III and IV	Enteric ward	—		
West I	Mediterranean Fever wards	2	6	1 night duty E wing for 3 nights just before sick
West II.........		1		1 probably a relapse case
West IV	Observation ward			
Surgical block ...	Surgical	10	11	1 night duty E wing for 6 nights, 1 mess kitchen for 4 days, 1 for 18 days W1, before which medical
Mess kitchen......	—	1		
General duties ...	—	—	—	1 case employed in various wards, but exclusively in Surgical Block, and is there included
Total	—	19		

It is seen that of the total number (79),* 15 had been working in the Mediterranean Fever wards just before going sick, but that one of these was almost certainly a relapse, and four others were employed here for so short a time that there is considerable reason for doubting any connection.

One notable feature is the large proportion attacked while in attendance on officers, not necessarily Mediterranean Fever cases, and it is curious also that of those who were attacked while on duty in the Mediterranean Fever wards so large a proportion should have occurred before isolation was adopted.

A record of night duty is to be found in 13 out of the 79, and in three of these a period of general duty, lasting five, nine, and 11 days respectively, intervened between the spell of night duty and their going on the sick list. Only in three cases was the duty in the Mediterranean ward, and two of these occurred during the period before isolation. The third, E. B., was on duty in the East wing from

* One ambulatory case omitted.

April 26 to May 1, 1905, and was placed on the list on May 14. He had previously been for months on day duty in these wards.

Of the rest, three were on night patrol, two on night duty in the Zymotic Block, one in E 1 when it was a surgical ward, one in the General Medical Block in 1904, and three closely following one another on duty in the East Block in 1906. In two of these latter, however, the period of duty there was only three and six days respectively, so that the chances of infection being then contracted are distinctly dubious.

Practically half the 13 and all the most suggestive cases occurred before isolation was adopted, and the evidence derived from this analysis of the employment at the time of onset cannot be said to favour the idea of infection by direct contact, as the result of attendance on Mediterranean Fever cases, or inoculation by biting flies. Once again, the chief characteristic is the very general distribution.

The consideration of the immediate duty upon which the patient was engaged to some extent loses its value as evidence from the fact that it is so difficult in this disease to determine the date of the first manifestations, more particularly when dealing with persons constantly exposed to the danger of infection. In the following paragraphs, therefore, the presence or absence of infection in those who did or did not work in the Mediterranean Fever wards is dealt with without discussing the question of dates:—

Before isolation was started in October, 1902, there had been from January 1, 1901, 31 persons working in the wards in which Mediterranean Fever was treated, of whom 13 developed fever during this period, and seven long afterwards. During the same time, of 16 who had not been on duty there seven developed the disease and three more subsequently.

After the commencement of isolation in October, 1902, down to June, 1906, of those members of the staff who have joined after July, 1902, 73 at one time or another have served in the special Mediterranean Fever wards either by day or night, or both, and of these 33 have subsequently fallen victims, but in one the case was an ambulatory one, and the man never went sick. Two, however, were made more or less immune by a previous attack in 1900. During the same time, of 59 men who have never worked in these wards 25 have developed fever. This latter section naturally includes also a larger ratio of recent arrivals, and therefore persons who have been less exposed to risk of infection.

Examining into the question of night duty in the same way, it is found that of 17 persons on night duty in the block in which these patients were treated before isolation was started, five were attacked during the period and six long after, while of 46 on duty in the

special fever wards after October, 1902, 15 subsequently suffered from fever.

Those on duty in summer would naturally be more exposed to the chance of infection by mosquitoes, yet if we divide the year into two periods we find the number attacked to be practically equal in both. As many men, however, have been on duty both in winter and summer, no accurate table can be constructed.

Since the introduction of mosquito nets in the fever wards in 1905 there have been only two cases out of 12 men exposed on night duty, which would appear to offer support to the theory of mosquito convection, but a large proportion of these men are recent arrivals, and since March, 1906, other factors have to be considered, so that a comparison is not exact. A similar objection applies to the day duty figures, which give 30 cases among 52 persons on duty before June, 1905, and only 10 cases out of 39 persons (including several of the preceding 52) for the subsequent 12 months.

Table XVII.—Showing Duration of Duty in Mediterranean Wards by Day and Night from October, 1902, to end of May, 1906, and the Proportion Attacked.

Time in days.	Number exposed.	Number attacked subsequently.	Remarks.
Under 20	7	4	
Between 20 and 40	16	8	
" 40 " 80	16	6	
" 80 " 120	11	5	1 other in 1900
" 120 " 200	13	7	1 " 1900
" 200 " 300	7	2	
Over 300	2	1	An ambulatory case
Total	72	33	

Table XVIII.—Showing Duration of Night Duty alone.

Time.	Number exposed.	Number attacked subsequently.
Under a fortnight	10	3
Between 2 and 3 weeks	7	3
" 3 " 4 "	4	2
" 4 " 5 "	17	4
" 5 " 6 "	4	2
" 6 weeks and 2 months	3	1
Over 2 months	1	—
Total	46	15

Taking as a whole the evidence with regard to the nature of the duty upon which the Sick Berth Staff have been engaged, it must be held that very little connection can be discovered with work amongst the fever patients, either by day or night, winter or summer, and that, just as with the hospital patients suffering from other illness, propinquity to these cases seems to exercise little influence in determining an attack.

Table XIX.—Month of Onset and Proportion affected each Year.

Month of onset.	1901.	1902.	1903.	1904.	1905.	1906.	Total.
January	—	—	1	1	—	1	3
February	—	—	—	3	—	3	6
March	2	—	1	2	1	5	11
April	1	2	1	—	—	2	6
May	1	3	1	—	1	2	8
June	—	3	1	2	4	1	11
July	—	2	1	1	4	—	8
August	—	2	2	2	1	—	7
September	—	1	1	—	1	—	3
October	1	2	2	2	—	—	7
November	—	4	1	2	—	—	7
December	—	—	—	2	—	—	2
Total	5	19	12	17	12	14	79
Number actually serving	31*	51	65	75	80	75 to May 22	

* Together with six who joined December 17, 1901. These figures naturally include a number of the same men in consecutive years. The total number serving was 171.

Like Chart 5, this table illustrates the fact that attacks of Mediterranean Fever display no special predilection either for the time of year at which mosquitoes are most active and numerous or for the months in which the largest numbers of fever cases are in residence. Once again the prevailing features are the lack of consistency in the various years and of relationship to any recognisable conditions.

It will be seen, for instance, that the system of isolation commenced in October, 1902, has had no effect on incidence, and this is even more plainly shown since the perfected isolation measures instituted in June, 1905. Nor has the shifting of the quarters of the staff from the little rooms in the near neighbourhood of the sick, under the eaves of East and West Blocks, described on p. 23, where they were located till about October, 1902, to a building some distance from the hospital proper, had any more effect in diminishing the number attacked.

Description of Quarters.—These consist of the two uppermost floors of a building (formerly the infectious hospital) projecting towards Calcara Creek from the south-western corner of the hospital grounds and about 80 yards distant from West Block. Built as it is alongside the cliff on which the hospital stands, it is considerably below the level of the rest of the establishment and is approached from it by the roof. The basement consists of dockyard storehouses. The upper floor is mainly taken up by a long dormitory with windows on three sides, one large one facing the present fever block. Another small ward on the lower floor, facing south, was used as a sleeping place until early in the present year. The large dormitory is partly divided lengthwise by arches, and at the northern end of the inner half a portion is screened off to act as a sleeping place for the night duty men. There are two cubicles at the south end of its outer half for the ward-masters. (See accompanying Plan, p. 54.)

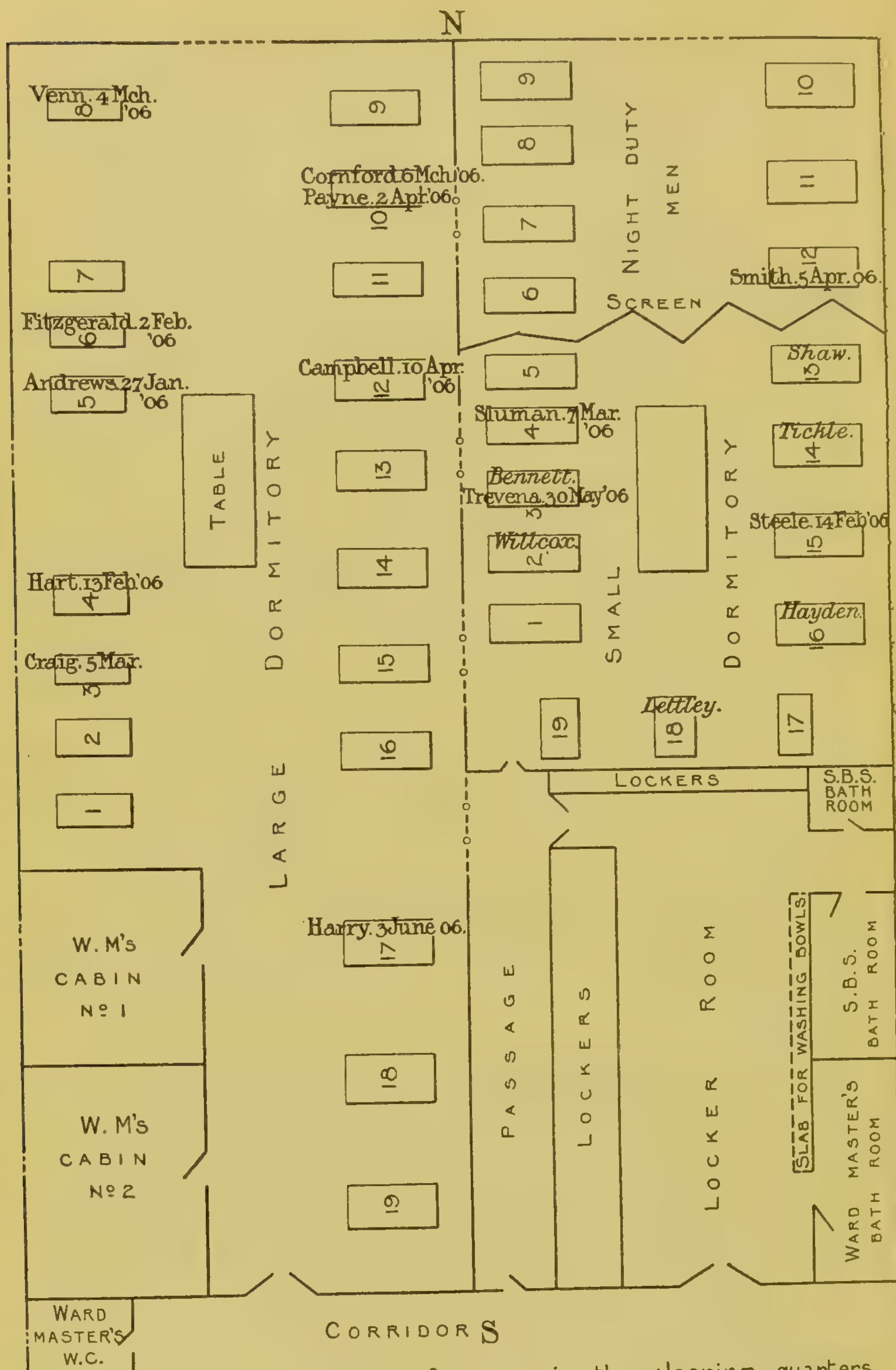
The sanitary arrangements conform with modern requirements and are in good order. No utensils are ever used in the dormitories for urinating, the latrine, which is entirely shut off from it, being invariably made use of. Four men are told off weekly for duties connected with the mess, two as cooks and two for cleaning and general duties.

When cases of Mediterranean Fever occur the practice has been to send bedding, but not the beds, for disinfection.

Mosquitoes are said to be very numerous in these quarters, and although few were sent for identification, the situation so near a large number of tanks, etc., found to contain larvæ, lends colour to this statement. A certain number of mosquito curtains were supplied for the first time in April, 1906, but only to some of the men.

Condensed milk has been used for a long time in the mornings, but till about the middle of April goats' milk, not infrequently unsterilised, was used in the afternoons for tea. The practice was then discovered and stopped.

The Outbreak among the Staff in 1906.—A considerable outbreak occurred in the early part of this year, commencing at the end of January. One case was put on the list in that month, three in February, five in March, two in May, and one in the early part of June. It had been noticed that mosquitoes were especially trouble-some during the winter, and it was found by Staff-Surgeon Whiteside, on examining the sleeping billets of these cases, that there was a marked grouping at the northern end of the outer side of the large ward close to the window facing the Mediterranean Block, the prevailing wind having been blowing in this direction. This, of course, suggested the possibility of aerial infection by dust particles or by biting flies. There was, however, another possible source of infection, inasmuch as Beds 9 and 10 E (*vide* Chart 6) were and had been occupied for a long time by two men who, without ever going on the



Showing the grouping of cases in the sleeping quarters of the Sick Berth Staff in 1905-1906.
1905 cases thus:—*Bennett*, 1906 cases thus:—Hart.

CHART 6.

list with fever, had been very seedy some year or more previously, and both of whom possessed high agglutinating power, in one case up to 1 in 300. One of these two subsequently went sick (Payne), and a second case occurred in a man sleeping in the same bed. The possibility of these men or one of them serving as the focus of infection, either by infected urine or by acting as the reservoir by which biting flies became infected, could not be ignored.

With the idea of eliminating one of these possibilities, the urine of both cases was plated out, but without recovering the specific micrococcus.

In order to collect evidence for or against the possibility of conveyance of infection from the Mediterranean wards either by dust or mosquitoes, Staff-Surgeon Whiteside kindly obtained, as far as possible, the sleeping billets of the cases in the previous year. As will be seen in Chart 6, these show an entirely different grouping and do not at all suggest this mode of infection.

Relationship to previous Attacks of Illness.—In 18 cases out of the total number, 78, the patients had previously been on the sick list within a month or two with what was diagnosed as some other ailment. In nine of these the disease was returned as catarrh, influenza, rheumatism, or simple continued fever, a fact which rather suggests that these were really the first manifestations of Mediterranean Fever. The following case affords evidence in favour of this. A.S. joined hospital in January, 1906, and at once went on the list with gonorrhœa from January 18 to February 9; he went sick again on April 5 with what was called influenza. On the 5th his blood gave a minus reaction; on the 7th, a doubtful 1 in 10. On the 18th he returned to duty apparently well, and on the 26th was vaccinated with dead *Micrococcus melitensis*, his blood being examined at the same time and found to react 1 in 50. On May 24 he again went on the list with developed Mediterranean Fever and reacted on May 26 1 in 100.

The remaining 8 cases were—gonorrhœa 2, chancroid 1, laryngitis 1, abscess 2, epididymitis 1, and anthrax 1.

It is an interesting consideration in the first place as to whether these cases were in any way connected with the subsequent attack, and if so, in what manner. There is considerable reason to suspect that of the first nine, some cases, at least, were the first manifestations, and this justifies to some extent the remarks made with regard to the unreliability of figures where the time element is taken into account.

In a large proportion, however, the fact of being on the list would mean the ingestion of milk, and, on the other hand, a certain amount of debility would be produced and lessen resistance.

Facts elicited by the Study of Individual Cases in Hospital Staff.—Eight of the Sick Berth Staff and one man belonging to the hospital guard were personally examined.

All of these men lived in adjacent quarters, the house where the guard were accommodated being just on the side of Bighi steps, opposite to the quarters of the staff which have already been described. The majority of these nine men went ashore occasionally, but five stated that they never slept out of their quarters.

Milk History.—Of the Sick Berth Staff, five admitted drinking milk by itself, a sixth had occasionally taken it with strawberries, but the remaining two denied having taken it except in tea. In forms sent in to my predecessor, information had been provided about eight other cases among the Sick Berth Staff. Of these, five admitted drinking milk, but one of them only in tea, while no details on this point were provided with regard to the remaining three. With regard to the man belonging to the hospital guard, which numbered 13, he had been in the habit of taking about a pint of milk daily, but said that he always heated it until a scum formed. According to his comrades, however, there was considerable reason to doubt the accuracy of this statement. Only 1 of his 12 messmates was in the habit of taking more than a very small quantity of milk, and that always in tea.

Mosquitoes.—Seven of the men had mosquito nets, but at least two had only lately obtained them. Five stated that they were badly bitten on arrival some time previously, but not latterly, two that they were occasionally bitten, and one not at all. The man belonging to the hospital guard said that there were numbers of mosquitoes about, but that they did not trouble him, although last year he suffered severely. He had a small net, but it only covered his face and hands, and was probably of little use as a protection.

Contact with previous Cases.—One man had, until six days before onset, been working for months in the Mediterranean Fever wards and six more had occasionally had cases of the disease to nurse, but not more than one or two, or for longer than a few days. In one case there was no history of contact with Mediterranean Fever cases.

Hand Disinfection.—One man, who had been nursing one or two cases in the officers' medical wards, admitted that he did not always disinfect his hands after dealing with possibly infective excreta, and two others were said to be casual and not unlikely to neglect the regulations with regard to this precaution. The others, however, all insisted that they were most careful about it.

No other case had occurred for months in the hospital guard, and the remaining men when examined all gave negative reactions. The only manner in which the patient was likely to have been exposed was as sentry in front of the fever block.

(c) *Mediterranean Fever occurring in the other Residences and Quarters.*

There are notes since January, 1902, of attacks in two nursing sisters, three surgeons, one chaplain, and four of the hospital guard.

Two out of the three surgeons were constantly engaged in laboratory work, and in both the infection was considered to have been acquired while so occupied. According to this, therefore, officers would not appear to suffer in any greater ratio than their fellows outside hospital. Although they must be regarded as far more exposed to the risk of contact infection or the attack of infected mosquitoes, there is no reason to imagine that they are more in the habit of taking milk than those latter.

(d) *Mediterranean Fever occurring in the Hospital Ship "Maine."*

As so many of the patients who develop their first attack in England or on passage home are conveyed in the "Maine," it seems well to indicate here the reasons for thinking that such persons have contracted the infection in Bighi before leaving Malta.

Although this ship is, on the whole, well fitted for the purpose for which she is used, no ship can possibly compare with a shore establishment as a hospital for cases in which infection may be spread by contact, and if this were a frequent method of propagation, the "Maine" ought to be a well-recognised centre.

She has been running since 1901, and has alternately been used as a hospital on the station and for the conveyance of invalids to home ports.

The Sick Berth staff, up to July, 1905, numbered 12 and a wardmaster, but since then have been increased to 18. As a rule they are drawn from home hospitals, and, as the majority are young attendants, a previous history of Mediterranean Fever is uncommon among them. Most of them sleep in their own quarters forward, but some in the convalescent ward in close relation at times to Mediterranean Fever patients.

Until March, 1906, it was customary for three to be on night duty in watches, one for each ward. Mosquitoes are said to be frequently troublesome in their quarters, but not much in the wards. The remainder of the crew number 96.

Accommodation and Routine.—There are two main wards, holding about 50 patients each, the cubic capacity per bed varying from 480 to 600 cubic feet. Ventilation, which is partially effected by exhaust fans, is said to be very satisfactory, but the latrines are situated before and open directly out of the wards, and if a door in the forward bulkhead of the latrine is open the air is driven into the ward.

There is no attempt at isolation of Mediterranean Fever, cases being indiscriminately mingled and no mosquito curtains used.

Everything is disinfected in cases of typhoid and tubercle, but on account of the numbers carried, the beds themselves are not always so treated in cases of Mediterranean Fever. Similarly, the stringent instructions with regard to hand disinfection by the staff in case of

typhoid are not made a point of in Mediterranean Fever, and no disinfectants are used for bedpans.

Milk Supply.—In January, 1904, an order was given that fresh milk was to be used when procurable, but it was not made use of to any extent and was rescinded in August of the same year, since which time no fresh milk of any sort has been used in the ship.

Employments.—From December, 1903, to May, 1905, she acted as a hospital for destroyers, and lay most of her time in Lazzarretto Creek. Previously to that her work varied between trips to England and employment on the station, and since that date she has exclusively been used for the former purpose. Up to December, 1905, she had made 12 trips home, and had conveyed in that time a total of 483 Mediterranean Fever cases and 736 other patients, these being on board an average of 10 days apiece. While on the station she has had under treatment 181 fever cases, with a total days' sickness of 3630, and in the corresponding period 881 cases of other illness, also for long periods. From these figures, it is evident that there was an abundance of infective material on board, even when lying in Lazzarretto Creek, in the near neighbourhood of innumerable breeding places for Acartomyia, and also that a large number of non-immune and debilitated individuals have been in close contact.

Whether or not cases which have developed at home after passage have actually been contracted on board, it is impossible to say definitely, but the following facts argue against it.

In a large proportion of the cases developing after leaving Malta in the "Maine," the onset is said to have occurred during the 10 days on passage in the ship.

Again, with the exception of two cases which occurred in August and September, 1902 (before fresh milk was prohibited), no records can be found of any definite case among her staff or crew. Nor was any patient whose case sheet was examined among the many admitted to Bighi from destroyers during the period in which the "Maine" was acting as hospital for them suspected to have contracted his disease on board.

This is a very different record from that at Bighi, and affords justification for considering the balance of probability to be in favour of their contraction there. In view of the large number of cases gathered together under disadvantageous circumstances as regards space, ventilation, and isolation, and with no special precautions, it also constitutes a decided argument against any form of contact infection.

(e) *Summary of the Evidence obtained in Connection with the Contraction of Mediterranean Fever in the Royal Naval Hospital, Bighi.*

The foregoing investigation may be held to have fairly conclusively proved the following points:—

(1) That a very considerable proportion of cases contracted the disease in Bighi.

(2) That the distribution of cases is very general, both as regards localisation in wards and the particular form of illness which acts as the forerunner, but that there is a special liability among surgical cases.

(3) That apparently this is to be explained by the fact that surgical cases provide the greater number of those patients who are resident for a long time.

(4) That there is no indication of place infection, nor does propinquity to the potential sources of infection appear to have nearly as great an influence in determining the subsequent development of the disease as duration of residence, while no definite relation can be shown either to the amount of infective material in hospital or to the particular season of year.

(5) In short, that little evidence can be obtained in favour of direct inoculation while in attendance on the sick, inoculation by biting flies, direct contact, or dust infection.

(6) The proportion affected, however, seems to vary to some extent with the amount of susceptible material in hospital in the shape of cases of other illness and with the absolute total of patients.

(7) There are occasional outbursts of epidemicity, however, which show no relation to any special condition, but under the circumstances (with an infected milk supply) it is difficult to banish the idea of the existence of a more than usually gross infection or of an equivalent absence of sterilisation. Even apart from the possible necessity of repeated dosage, the conditions of supply are such that long residence would favour the possibility of ingestion of infective milk. Finally, the direct evidence obtained about milk and, above all, the total cessation of cases since there has been no doubt about its sterilisation, are strongly in favour of its having been the infective agent.

II.—Analysis of Cases showing no very definite Connection with Residence in Bighi.

Table XXI.

Year	1902.	1903.	1904.	1905.	1906.	Total.
Doubtful hospital cases	2	6	7	3	—	18
Cases in hospital more than 3 months previously	5	6	1	4	4	20
Officers, ward room	39	20	16	18	7	100
,, gun room	43	16	15	9	7	90
,, warrant	5	1	—	1	2	9
Total	87	37	31	28	16	199
Maltese service men	7	6	6	8	8	35
Dockyard employees (English)	4	4	1	—	5	14
Men belonging to depôt ships in Malta	7	11	8	11	2	39
Cases giving no reaction or otherwise indefinite	—	5	2	2	2	11
Foreigners	—	1	—	—	—	1
No particular characteristics	81	85	89	98	47	400

III.—Occurrence of Mediterranean Fever among Officers as compared with Men.

Of the 471 patients who had previously been under treatment in Bighi for other illness, 21 were officers, 14 being ward room, 5 gun room and 2 warrant, while the list of cases having no obvious connection with treatment there (*vide* p. 60) includes 199 officers of various grades or 220 in all as compared with 1056 men. Officers therefore suffer at the rate of one to every six men. The relative proportion of officers to men in the Fleet, of course, varies slightly,* but may be put down at 1 to 16 and the incidence is accordingly very much greater among the former than the latter. But the most curious feature is the difference between them as regards previous hospital residence. Thus, of 220 officers only 21, or if cases among the staff are included, 25, give such a history, whereas of 1056 men, 450 together with 74 of the staff and 4 of the hospital guard, or a total of 528, enter into this category. In other words, it appears to be necessary for the man to go to hospital to contract his fever in about 50 per cent. of the cases, while the officer is enabled to do so without this in all but about 11 per cent. The explanation that at once offers itself is, that the officer is allowed to have milk in the ship

* Early in 1906 there were 846 officers in a total of 13,628.

and that the men are not, except when on the sick list, and that the officer is far more liable to take milk in various forms when ashore than is the man. Judging from personal experience, it would seem rather a difficult matter, unless one is constantly on the alert, to avoid taking in clubs and hotels in Malta raw milk in such various insidious forms as creams, meringues, sauces, ices, etc.

It might, however, be suggested that the officer is more exposed on account of his shore-going propensities, and in this there is a certain degree of truth. With the exception of the comparatively small number of officers who live ashore, however, the bluejacket is far more in the habit of sleeping there, more particularly as compared with junior officers, who contribute so many of the cases, and not only so, but he is likely to sleep in places more densely populated, more infested by mosquitoes, and where beds are not protected by nets as they are in most clubs or hotels. This is illustrated in the personal investigation of the movements of patients attacked by Mediterranean Fever as detailed on p. 100.

It may also be regarded as somewhat remarkable that the officer should be comparatively immune after residence in hospital and that this rather suggested the influence of the greater isolation which cabins provide there. Not only, however, has the small part played by propinquity to the fever wards been sufficiently demonstrated, but a good many officers must have been accommodated in rooms considerably nearer to the fever block than the men in the surgical wards for instance. It is distinctly curious, however, that in view of the large amount of milk allowed to officers they should so rarely be attacked after stay in hospital.

Table XXII.—Comparing the Ratio of Officers and Men respectively after Stay in Hospital.

Year	1902.	1903.	1904.	1905.	1906.	Total.
Number of officers exposed	92	100	108	75	17	392
Number attacked...	4	4	4	7	1	20, or 5·1 per cent.
Number of men exposed	1192	1058	1238	1406	244	5138
Number attacked...	92	81	82	163	27	445, or 8·6 per cent.

It is seen, therefore, that there is a very decided difference, but it is probably explained to a large extent by the next table, which

contrasts the duration of residence in the two cases. A point worthy of note is that the percentage of officers admitted for Mediterranean Fever to the total admissions of that disease is much higher than the percentage admitted for other illness, which affords further proof of their special liability to the former.

Table XXIII.—Contrasting the Duration of Residence in Hospital among Officers and Men admitted to Bighi for Illness other than Mediterranean Fever.

Days	Under 10.	10 to 20.	20 to 30.	30 to 40.	Over 40.
Duration of residence of officers from January, 1902, to end of first quarter, 1906	80	126	76	46	63
No. developing Mediterranean Fever	2	8	4	4	2
Duration of residence of men for 1905 and first quarter of 1906 (from Table VIII)	295	470	334	240	420
No. developing Mediterranean Fever	20	29	33	31	85

The difference shown here is only what might be expected, as with officers Mediterranean Fever itself is the principal disease necessitating a long stay in hospital. From venereal disease, which constitutes the bulk of such cases among the men, officers are comparatively free, and they are rarely admitted for hernia or similar operations. The number exposed, too, during months such as May, 1905, in which there was a special danger of contracting the disease and in which a very large proportion of the total apparently became infected, is altogether insignificant as contrasted with the number of men in residence at the same time, and this also would tend to a larger ratio among the latter.

The yearly returns are also interesting. In 1902 there were 91 officers attacked, in 1903 41, in 1904 35, in 1905 35, and in 1906 17. The first year, which provided by far the greatest number, was peculiar in that fewer men suffered than usual, and the Army figures were also unusually low. These facts are far more compatible with some strictly limited source of infection such as milk supply than with conditions such as dust or mosquitoes, which would act more generally.

IV.—The Connection of Outbreaks of Mediterranean Fever with Stay in Dry Dock or alongside Dockyard Wall.

For a long time such a connection has been a matter of common observation and has been frequently cited as a strong argument in favour of the mosquito-borne origin of the disease. This was therefore one of the questions which demanded enquiry. Returns were obtained and forms made out giving as far as possible the history of ships docking or alongside the dockyard wall since January, 1904, the cases occurring during this time, and also in the preceding and succeeding three months, and finally any points in the previous history of such cases which serve to throw light on their origin. The returns, except for the actual period in dock, etc., are not absolutely complete owing to the fact that several ships have left the station or recommissioned and that until about June, 1905, only patients under treatment in Bighi are included as a rule. For the most prominent examples they are, however, complete, and at all events may be considered so for the occurrence of Mediterranean Fever while actually in dock, or alongside.

Description of Docks and Surroundings.—Before entering upon the consideration of the evidence derived from these returns, it is as well to give a short description of the docks involved.

Nos. 3 and 4 docks are situated, one somewhat in front of the other, along the northern or Senglea side of French Creek below the high bastion wall which separates them from the thickly populated streets of Senglea. These docks accommodate the battleships and larger cruisers chiefly. According to the returns obtained, battleships were docked in No. 4 26 times, 1st class cruisers 5 times, and smaller ships 5 times. No. 3 took 1st class cruisers twice and the smaller ships 16 times.

Possible Reservoirs of Infection in the Neighbourhood.—No. 4 dock, being furthest down the creek, is in relation only to Senglea, the opposite Corradino shore being practically uninhabited. No. 3, some 250 yards further up, abuts at its top end on Cospicua near the Naval stores and the market, while Senglea adjoins it alongside. From Senglea there were notified, in 1904, 12 cases, in 1905, 13, and in 1906, 11, up to the beginning of October. For Cospicua the figures were 21, 17, and 8 respectively. The spot maps which have been made out show that fully half those in Senglea and the majority of those in Cospicua were located at a considerable distance from these docks. Although it is unfortunately true that the civil notifications cannot be depended upon, it would be rather singular, to say the least of it, if this comparatively small number of cases, very generally distributed both as to time of year and localisation, even assuming the notification of only a small proportion, were sufficient

to account by means of infected mosquitoes for the considerable outbreaks that have occurred in ships in dock, more particularly taking into consideration the small number of mosquitoes found infected in hospital wards crammed with acute cases.

The dockyardsmen, several of whom have been shown by Shaw to be suffering from ambulatory Mediterranean Fever, form another possible source of infection, but as work in the yard ceases at 5.30 p.m., only Stegomyia or Acartomyia would be likely to become infected from them. With regard to the question of infection being conveyed from one case to another in the ship, not only must it be remembered that, while ships are in docks, cases are usually sent to hospital on the first sign of illness, but the chronological sequence of cases in the majority of instances does not suggest this mode of infection, as is shown in the returns.

Nos. 1 and 2 docks are situated in line, wedged into a sort of triangle at the top of Dockyard Creek, and are absolutely surrounded by a crowded part of Cospicua at far closer quarters than either of the others. Accordingly the chances of infection should be greater here, but these docks are used principally for destroyers, the crews of which are usually hulked on these occasions, and they have not therefore been taken into account. The only ships of any size which are included in the returns are the "Harrier," torpedo gunboat, which was in No. 2 for June, 1904, no cases occurring, and the "Surprise," despatch vessel, in the same dock last December and January with a similar result, although in her case two patients sent into hospital for other disease contracted Mediterranean Fever while resident.

Evidence of the Presence of Mosquitoes.—There can be no doubt that the domestic species are extensively bred in the houses all round, but in order to investigate the sources in the near vicinity of the docks a survey was made in June, at a time when both Nos. 3 and 4 docks were occupied and mosquitoes were greatly complained of by the ship in No. 4. The electric light connections were being laid, with the result that there were several collections of stagnant water around both docks. No larvæ were found anywhere around No. 3, but from several pools near the other dock they were obtained, and from one pool Acartomyia were bred out. In addition to these artificial collections of water, larvæ were found at the base of several of the hydraulic capstans, of which there are six near No. 4 and one only near No. 3, and in the surface-water channel at the bottom of the subway around the former dock which was blocked in several places, thus giving opportunity for water to collect. All of these proved to be some variety of Culex.

On several occasions collecting boxes were sent to ships in dock to procure the adult insect for identification, but none were ever obtained.

After the survey had been made, various recommendations for

prevention were made in conjunction with Fleet-Surgeon Hardie of the dockyard, and these may perhaps have reduced the numbers, but owing to the proximity of the houses it is unlikely that any very great result would be obtained. It is interesting to note that neither of the two ships referred to had any cases then or about that period. At the same time it was noted that the presence of the refuse boats which were kept alongside the wall between the two docks attracted very large number of flies in the near vicinity of the ships.

Latrines.—There are a large number of these around both docks, and all seemed in very good order. Separate places are kept for dockyardsmen and naval people, but it is said that the latrines for the latter are occasionally used by the dockyardsmen. One latrine for dockyardsmen, close to No. 4, is placed above a store and involves mounting several steps, the result being that the ground at the foot is extensively used for urination.

Possibilities of Infection apart from Convection by Biting Flies.—It seems to be taken for granted by advocates of the mosquito theory that dock outbreaks are necessarily to be attributed to this method of dissemination. From what has just been said it can be seen that contamination of food or drink by flies is by no means an impossibility, and that inoculation while cleaning latrines is equally to be considered. In addition, however, to these possible sources of infection, it must be remembered that while ships are in dock, far more patients are sent to hospital than usual. The cases of the "Irresistible" and "Vulcan," quoted later, give illustrations of this fact. The explanation is that, while in dock, a ship is more than ever an unsuitable place for a sick man, the sick-bay, moreover, is often under repair, and also there is no latrine available on board. It is often regarded, too, as a favourable opportunity for sending patients for operation, while tonsillitis and other similar ailments are apt to follow the free use of paint, etc., in the ship, and a prolonged stay usually means a considerable increase in the number of venereal cases.

Other possibilities of infection are to be found in the presence on board of numerous Maltese dockyardsmen, whose ideas of sanitation and decency are crude in the extreme. It is not altogether infrequent to find that, when working down in the double bottoms, to avoid the fatigue of coming on deck, they have converted the part of the ship in which they are working into a temporary latrine. Instances of this have been obtained even from destroyers.

Facts shown by the Returns of Docking referred to.—The most striking characteristic about these is the absolute lack of consistency in effects produced by docking on the incidence of the disease. As a general rule, perhaps, a lengthened stay in dock or alongside appears to be followed by a considerable number of cases, whereas a short stay, no matter the season, does not seem to have such effect. On the other

hand, however, instances are observed, such as the 63-day stay of the "London" in January, 1904, where more cases occurred in the preceding three months than during the period of stay and the succeeding three months together. The "Formidable," exposed to practically the same conditions for a similar time, provides a considerable number of cases, and the "Bulwark," in a much shorter time, and earlier in the year, provides more than either. Again, the "Formidable," exposed for 124 days in the beginning of 1905, shows but half a dozen cases, whereas the "Implacable," at an earlier period of the year, with 132 days, shows about 20.

The best marked instance is to be found in the "Irresistible" in 1905, but the "Vulcan," although alongside nearly as long a time, a little earlier in the year, seems to have escaped more lightly than many ships exposed during the winter. This inconsistency in result would appear to point rather to something in the ship than in the docking.

Influence of Season.—The best marked example occurred in mid-summer, but instances are numerous during the cold months. Therefore, although the tendency seems to be increased by long exposure in the summer, cold weather does not exhibit any inhibitory influence.

Docks Affected.—The majority of outbreaks have occurred in No. 4 dock, but this has been shown to be used for most of the big ships. The experience of the "Vulcan" in 1905 shows that the danger exists almost if not quite as much as in No. 3 dock.

Influence of previous Hospital Residence.—But more interesting than all this are the facts shown with regard to the influence of previous residence in Bighi. A study of the returns shows that in something like 50 per cent. of the cases the patient had previously and recently been there, and that of those who had not, a very considerable proportion indeed are officers. Moreover, in a number of cases they had actually been in hospital during all or a great part of the time the ship was in dock, and were therefore exposed to dock conditions for a shorter time than their more fortunate messmates.

The outbreak in the "Irresistible" provides an excellent illustration. This battleship, with a complement of 780 men, went alongside the dockyard wall on April 15, 1905, and into dock on June 19, remaining there until August 1, a total of 107 days, 41 of which were spent in dry dock. During the entire year she contributed a total of 32 cases of Mediterranean Fever, of which no less than 22 actually came on the list during this 107 days and 5 more in the subsequent three months. At first sight, therefore, no more admirable illustration of mosquito-borne infection could be adduced: a severe outbreak coincident with docking in a ship previously comparatively free, at the appropriate time of year, and, in short, all the necessary conditions. When, however, the history of these cases is enquired into in more detail,

a very different impression is left. Thus, one man went into hospital for hernia five days after docking, and contracted the disease while resident there; a second was living ashore at Castille Signal Station all the time, and was, in fact, temporarily borne on the books of the "Egmont." Yet another also developed the disease while resident in hospital for other illness, and in all probability contracted it there. Of the total 27 cases occurring in close relation to the period in dock, no less than 15 in addition to these three had recently been in hospital for other illness, although in two instances this was diagnosed catarrh and was possibly the first manifestation of fever. A sixteenth case was one of relapse. Of the eight remaining, three occurred among officers. Among the men, therefore, five cases only had no apparent connection with hospital, and of these, one went on the list eight days after first going alongside, and a second 81 days after coming out of dock. Not only is this the case, but if the dates of residence in hospital are examined, it is seen that the majority of these men were there for a large part of the 107 days, and that the period of exposure to dock influences was in one as short as three days, in one 17 days, and in four about 20. In certainly the vast majority it was very much less than the rest of the ship's company.

Fleet-Surgeon Woodwright kindly supplied a list of people sent to hospital for other diseases during the 107 days. This gives 55 men during this period as compared with three in January, nine in February, seven in March, and five up to April 15, thus giving a good illustration of the increased number sent to hospital which always, as previously stated, follows docking. Adding these together, 79 men are seen to have been in hospital since the beginning of the year, and of these 15, or 19 per cent., subsequently developed fever, whereas of their 701 longer exposed shipmates only eight, or about 1 per cent., did so during the same period, and three of them were officers. If this were an isolated incident it might be regarded as coincidence, but it is not so; throughout the return practically the same thing is met with. The "Vulcan," for instance, sent five men into hospital before March 21, 1906, when she went alongside, and 30 more during her stay of 84 days. Among these 35 men, 10 subsequently developed fever, while among the 414 having no recent hospital history only five, including one officer, developed the disease during the same period.

If the cause were to be found in what used to be described as some miasmatic influence to which only the weakest succumb, this could be understood, but it is difficult to picture infected mosquitoes choosing their material in this deliberate way, and the same objection applies to all forms of contact infection.

Altogether, the evidence would suggest that docking increases the incidence of the disease, principally by favouring residence in hospital, possibly in a limited number of cases by mosquito infection or con

traction during sexual intercourse, more probably by contamination of food by flies, or inoculation by infective urine in latrines or parts of the ship. It suggests in addition, however, that it acts also by producing other illness which lowers resistance and acts as the spark to produce the explosion in cases where Mediterranean Fever is latent in the individual, or that it may do the same by the depressing influence of the heat and general discomfort met with while in dock, without the intervention of actual illness.

V.—The Possibility of a Connection between Attacks of Mediterranean Fever and Sexual Intercourse with Infected Persons.

That this disease may have some etiological connection with sexual intercourse with infected persons is a conception that has occurred to more than one student of its epidemiology, the thought being prompted by the frequency with which it is associated with a venereal history, and the investigation, therefore, of the chances of such a method of infection has been made a part of the enquiry from its commencement. The results of the experiments and laboratory investigations made this year have shown that there is no doubt about its possibility, and it is left for epidemiological investigation to show whether this can be regarded as a frequent method of contraction.

Evidence with regard to this may be derived from two chief sources, first, the study of cases in which the attack was either associated with, or closely preceded by, venereal disease, and, secondly, the facts as to the history of exposure to possible infection in those cases personally investigated. Two points brought out while studying the development of Mediterranean Fever in patients recently treated for other illness appear to have a bearing on the subject. Table VII, for instance, shows that there is a decided difference in liability between persons suffering from the initial and the later manifestations of venereal disease notwithstanding long residence in both. Another interesting feature consists in the large number of patients in whom the precedent disease is complicated by glandular enlargement, and in whom also any operation on the glands results in an outburst of fever. Much the most probable explanation of this is that these bubo cases are those who are on milk diet, and in whom especially debility is produced, but there is a remote possibility that the organism is set free from these glands.

Notes have been made of 105 attacks since January, 1902, which were either associated with or closely preceded by the initial manifestations of venereal disease. Of these, 13 were found on investigation to be relapses or sequelæ, and are omitted. The remaining 92 contribute 41 contracted in Malta, 24 elsewhere, chiefly Greece, the home ports, Crete and Egypt, and about 27 there is no information available.

Of those contracted in Malta, the interval between the date of exposure and the onset of fever symptoms was in 10 cases under one month, in seven under two, in 11 under three, in 11 between three and six, and in two over that time.

The following cases include all those in which the evidence at all favoured possible connection :—

1. H. T.—Placed on sick list June 29, 1902, with acute gonorrhœa, and on July 26 developed Mediterranean Fever.

2. G. A.—Admitted to hospital on July 2, 1902, with history of acute gonorrhœa, temperature and headache following after a few days' treatment. This persisted in hospital, and there was positive reaction on July 17.

3. W. C.—Contracted syphilis, primary, in Malta on June 3, 1902. On July 8 was placed on list with temperature and a bubo. This was opened, but typical pyrexia persisted, although reaction negative till September 25.

4. R. B.—Entered on sick list December 5, 1902, with gonorrhœa, cystitis, and fever which persisted after admission to hospital on December 16. Reacted on January 22.

5. G. V.—Admitted on April 18, 1903, with uncomplicated gonorrhœa, contracted in Malta on the 11th. Tenderness of instep complained of on 22nd, and next day the temperature rose. On May 1 he had pain in back and headache, and reacted on May 26. This man was the S.B. attendant in hospital, whose duration of residence before the onset of fever was the shortest of all those dealt with.

6. A. B.—Contracted gonorrhœa on April 4, 1903, in Malta, and on April 26 complained of pain in right ankle, hip and thighs. Reacted May 9.

7. W. R.—Contracted gonorrhœa on March 12, 1903, in Malta, and was admitted to hospital on the 21st with a perineal abscess. The latter was opened and the temperature fell, but again rose on April 7, with shivering, although wound was healthy. Pyrexia persisted till April 13. He was discharged May 13, and onset of Mediterranean Fever June 19.

8. E. M.—Contracted gonorrhœa in Malta on September 12, 1902, and was admitted to hospital on October 3 with epididymitis and pyrexia, which persisted with occasional exacerbations until 23rd. No change then till December 16, when onset of Mediterranean Fever symptoms. Reacted December 28.

9. G. R.—Contracted gonorrhœa in Malta on January 3, 1904, and was admitted to hospital on the 28th with pyrexia and pain in perineum. The temperature was high and had risen three days previously and he had rigors, nausea and headache. Nothing was found to account for perineal pain. He reacted on February 11.

10. T. D.—Contracted gonorrhœa in Malta on December 13, 1903. Onset of Mediterranean Fever symptoms on January 14, 1904.

11. W. D.—Contracted syphilis at the end of September in Malta and was admitted on October 29. Two days later complained of pain in wrist and had rise of temperature. Reacted November 10.

12. C. W.—Contracted gonorrhœa in Malta. Admitted June 15, 1905, complaining of pains all over and had gleety discharge which two days later became profuse. Reacted on June 20.

13. P. W.—Contracted gonorrhœa in Malta about July 3, 1905, and reacted on July 11. Stated, however, that he had been feeling ill since 1st.

14. E. E.—Contracted gonorrhœa on October 4, 1905, at Malta, and was admitted on 16th with pyrexia. Reacted on October 20.

15. J. S.—Admitted for gonorrhœa on June 4, 1906, and reacted on June 8.

16. N. T.—Contracted gonorrhœa in Malta about three weeks before going sick

with Mediterranean Fever, and noticed it two or three days after admission. Had been feeling ill, however, off and on for three weeks.

17. G. P.—Contracted gonorrhœa in Malta about middle of October, 1903. This was followed by orchitis and pains in hip and shoulders, and by temperature at nights. Admitted to hospital on November 17, and gave good reaction at once.

The following cases are quoted to show that the development of Mediterranean Fever symptoms is not confined to patients whose venereal disease is contracted in Malta :—

1. T. T.—Contracted gonorrhœa on May 3, 1903, at Portsmouth and put on list on May 11. Discharged to Malta hospital from "Porpoise" on May 21. Rise of temperature and pain along cord on May 29 and reacted on May 30.

2. J. H. N.—Contracted syphilis primary and gonorrhœa on December 13, 1903, at Canea, and on January 15, 1904, developed symptoms of Mediterranean Fever.

The above cases include all which could be found in which the dates were at all suggestive of a simultaneous contraction of the two diseases, and it will be seen that the evidence could not, by the greatest stretch of the imagination, be called anything but inconclusive, and, as they were all treated in Bighi Hospital, is in the large majority far more suggestive of their having been contracted there.

Facts Elicited from the Study of Individual Cases with Regard to the Contraction of the Disease during Sexual Intercourse.—Of 59 persons in whom it was possible to obtain information on this point, 42 denied that they had ever had intercourse on the station, six admitted to having done so, but not for months, four had recently done so, but in places other than Malta, while seven admitted recent intercourse in Malta itself. In one of these latter cases the patient remembered having been severely bitten on the eyelid by some insect, but this was the only case in which such a history could be obtained. The intervals varied from three to six weeks before onset.

This is not a point upon which negative evidence can be regarded as very trustworthy, but taking it for what it is worth, it is not suggestive of any large number being contracted in this way.

Section B.—PREVENTIVE MEASURES INSTITUTED AGAINST MEDITERRANEAN FEVER IN THE NAVY.

I. Methods of Prevention Undertaken in 1906.

Protection from the Attacks of Mosquitoes.—The experiments and investigations carried out in 1905 by the members of the Commission had been very suggestive of a mosquito-borne infection, and after the arrival of the military members of the Commission this year it was decided on their recommendation to isolate all military Mediterranean Fever patients in the long ward of Valletta Hospital, and to render this mosquito-proof.

It has already been stated that systematic oiling of tanks, etc., and the use of mosquito nets had been for some time an established

routine at the Naval Hospital, while isolation had been adopted since 1902, but it was thought that if, in addition, one of the wards containing patients suffering from other illness, and which had recently contributed several cases of the disease, were treated similarly, it would act as a useful control to this experiment of protecting the infective cases from mosquito attack in the military hospital. Accordingly, on April 26, this suggestion was submitted to the Deputy-Inspector-General, and was forwarded by him to the Admiralty, and subsequently approved, but, fortunately, up to the end of October the work had not been commenced, so that any diminution in incidence which has occurred in the Navy cannot in any way be attributed to this proposed experiment.

Disinfection of Patients' Effects.—On May 4 I made the further suggestion that the effects of all patients, whatever their disease, admitted to hospital, should be disinfected, in order to prevent the possibility of undiagnosed cases being overlooked, but this measure was found to be impracticable, and it was likewise impossible to carry out on board ship processes akin to the disinfection and evacuation of barrack rooms introduced this year.

Control of Milk Supplies.—From a naval point of view, therefore, the only prophylactic measures which have been undertaken consist in those directed to the more efficient control of the milk supply.

So far as the Naval Hospital is concerned, the first step in this direction was taken by Staff-Surgeon Whiteside. Suspecting from the condition of the milk on several occasions, after issue to the wards, that it had not been properly sterilised, he had it intercepted on its way from the kitchen on each day from March 31 to April 7, 1906, and a sample taken with all needful precautions, and conveyed to the laboratory. On March 31 and April 1 and 4 an organism corresponding in morphological and cultural characteristics to *Micrococcus melitensis* and clumping with Mediterranean Fever serum was successfully isolated. On this being reported to Deputy-Inspector-General Bentham, the requisite measures were at once taken by him to ensure that there should in future be no possibility of neglecting the instructions, already existing, with regard to sterilisation of milk, and it may be regarded as practically certain that since this date there has been no repetition of this.

On May 4, as information had been obtained that some of the Sick Berth Staff had been drinking unsterilised milk in their own quarters, notwithstanding instructions to the contrary, I wrote to the Deputy-Inspector-General drawing attention to the fact that only the milk for the hospital itself was sterilised in the hospital kitchen, the supply for the various residences and quarters being sent to their own kitchens and, presumably, sterilised there. In this letter it was urged that this multiplication of sterilising stations added greatly to the chances

of some of the milk escaping, and the suggestion was put forward that the sterilisation should be carried out at the main gate, and no milk admitted into the grounds until this had been effected.

This was approved in principle, though with some alterations in detail, and was later carried out, but from May 21 to June 1 any such procedure was unnecessary owing to a strike of the goatherds, which rendered obligatory the use of preserved milks.

As a further guarantee of sterilisation I suggested on May 16 the routine use in hospital of the ortol and peroxide of hydrogen test, which had been mentioned to me by Dr. Eyre, and on the return of the fleet on May 23 from the Piræus its use was likewise recommended in all ships through the P.M.O. of the flagship, and a general memorandum was promulgated to that effect by the Commander-in-Chief.

On July 3 the Deputy-Inspector-General had made arrangements for the further examination of the goats supplying the hospital, and for the issue of identification labels for them, but after some 60 samples had been taken the goatherds objected to anything further being done and returned the labels, whereupon the supply was very rightly discontinued, and preserved milk has been used exclusively ever since.

Milk in the Fleet.—During the absence of the fleet on manœuvres, in June and July, I made an attempt to examine into the sources of milk for officers' messes, and the enquiry was started with two large dairies which supply the greater proportion of the ships. The system upon which both of these obtained their milk was, judging from the description given, of the most unsatisfactory nature. For the regular supply apparently a certain small number of goat or cow owners were called upon, but for any extraordinary occasion, such as the arrival of the fleet, milk was often obtained from quite casual sources. One of these two dairymen entirely failed to persuade any of the people who supplied him to allow even samples of milk to be obtained. After much trouble and one ineffective visit consent was obtained in the case of one owner of a small herd at Sliema who helped to supply the second dairy. Here, however, of the total of 20 goats half were said to be pregnant or, for other reasons, not yielding milk, an assertion which could not be tested, as the animals were located in a small back street, and so intermingled with other herds that it was impossible for anyone but the owner to distinguish between them. The 10 samples obtained were examined by Zammit's test, and one which gave a good reaction was plated out in the laboratory and reported to have yielded *Micrococcus melitensis.*

Accordingly, on the return of the fleet on August 4, I sent a letter to the P.M.O. of the flagship for submission to the Commander-in-Chief, detailing the result of these investigations and the exceedingly

unsatisfactory conditions under which milk was supplied to officers' messes, and also giving a short summary of the facts known up to that time, which suggested milk as the vehicle of infection.

The following alternative suggestions were also submitted :—

(1) The absolute substitution of preserved for fresh milk in the fleet.

(2) The prohibition of the use in the fleet of milk obtained from owners who refused to brand their animals in an unmistakable manner, to give samples of milk or blood at any time, and to milk them only in certain places and certain times to facilitate inspection by a special officer.

(3) The provision and entire control of a special milk supply by the naval authorities.

On the arrival of the fleet on August 4 the Commander-in-Chief repeated the order that all milk obtained in Malta was to be boiled. It was then to be tested by the ortol test, and the completion of this process to be signalled each morning to the flagship.

Ice Creams.—It was discovered on the return of the fleet in October, owing to a question being asked by the Commander of one of the ships as to the possibility of infection through ice creams, that these were in some cases being purveyed on board by hawkers. The attention of the P.M.O. of the flagship was therefore drawn to this, and the experiments made this year in the laboratory, which would suggest that these must be regarded as under suspicion, were referred to, with the result that a general memorandum was issued prohibiting their sale on board and warning officers and men that their consumption was attended with some degree of risk.

From this account it can be seen that in the Naval Hospital the milk cannot be said to have been certainly sterilised before April 9, and that the Sick Berth Staff and residents may have taken small quantities unsterilised for a week or two later. With regard to the fleet supply, the ortol test, when made use of between May 23 and June 5, showed that in two ships at least milk has not been boiled as supposed, but ever since the departure of the fleet from Malta on June 5 it is probable, from the increased attention paid to it and the use of this test, that there have been very few, if any, occasions on which it has escaped sterilisation.

II.—Incidence of Mediterranean Fever since the Foregoing Measures were Instituted.

Incidence in the Fleet.

Table XXIV.—Giving the Admissions per Month since January, 1902, excluding Relapses.

Month.	1902.	1903.	1904.	1905.		1906.	
	In Bighi.	In Bighi.	In Bighi.	In Bighi.	Others.	In Bighi.	Others.
January	7	18	27	17	—	20	4
February	8	20	28	7	2	21	11
March	26	30	24	17	—	16	6
April	27	20	28	29	—	22	3
May	47	33	4	31	7	19	5
June	34	45	15	46	1	8	15
July	27	12	22	30	20	4	8
August	22	4	12	16	9	3	4
September	26	25	8	4	2	2	—
October	32	18	44	12	—	3	1
November	22	29	17	24	3	1	—
December	16	21	17	14	2	—	—

In connection with this table it must be first of all noted that the fleet has this year been very considerably reduced, and further, that one or two of the larger ships have spent some time in England while recommissioning, and have returned with almost new crews.

In the second place, most ships have been absent from Malta for an unusually lengthy period. From February 9 to April 19, May 4 to 23, June 5 to August 4, and from August 13 to September 30, almost the entire fleet was absent. In 1905 the majority of the fleet made a short cruise early in the year, and again left on June 17, returning about August 26 and remaining till September 6, when another cruise was made, lasting till September 30.

The diminution in the number of cases therefore to some extent supports the statement made by Shaw to the effect that Malta is the headquarters of the disease, and that in the Navy very few cases are contracted elsewhere.

Nevertheless there is considerable reason for supposing that these two facts by no means explain the total decrease.

Incidence among Persons Constantly Resident in Malta.—If, for instance, the figures for the stationary ships and hospital on the one hand and the dockyard employees and the naval Maltese admitted to Bighi on the other are contrasted, it is seen that the former, to whom the precautions above detailed with regard to milk apply, show a very

decided reduction in the number of cases of Mediterranean Fever, whereas the latter, among whom no special measures have been adopted, show no diminution.

Table XXV.—Contrasting the Monthly Occurrence of Cases in the Hospital and Stationary Ships, and the Dockyard Employees and Naval Maltese admitted to Bighi for 1905 and 1906.

Month.	Hospital and stationary ships.*		Dockyard employees.†		Naval Maltese.†	
	1905.	1906.	1905.	1906.	1905.	1906.
January	2	2	—	—	—	1
February	—	5	—	—	1	1
March	3	5	—	1	1	—
April	1	5	—	—	1	—
May	8	6	—	1	—	—
June	9	1	2	1	2	3
July	5	1‡	—	1	—	1
August	3	—	—	—	—	2
September	1	—	—	—	—	1
October	1	—	—	1	—	—
November	3	1‡	—	—	1	—
December	—	—	—	—	2	—

* Milk precautions adopted after April, 1906.

† No special milk precautions.

‡ Both these men were living ashore and victualling themselves. In the last case a distinct milk history was obtained.

Pointing in the same direction is the fact that since the return of the fleet on September 30 to January 13, 1907, only six cases have been notified from Malta, Gibraltar, and the home hospitals. Of two which occurred in October, one, a warrant officer of the "Bulwark," was originally admitted with symptoms of pleurisy and, although he gave a reaction shortly after, was regarded as a doubtful case. The second, a domestic, lived ashore and gave a definite milk history. A third case, occurring in November, is the man referred to in Table XXV as having been victualling himself ashore and as also giving a definite milk history, and the fourth case, which likewise developed in November, was an officer of the "Surprise" who went straight home in the "Maine." The date of onset in his case is given from Haslar as July 21. Two cases have been notified from the home hospitals, one being a man belonging to the "Diana" whose illness commenced in October, and the second a Ch. S. B. steward from Bighi who has been frequently sick with "rheumatism" and the onset in whose case is indefinite. He was admitted to Haslar in November.

A third fresh case was also notified from Haslar, but this illness is stated to have commenced in March, when he had been three months under treatment for bubo in Bighi. With the exception of the S. B. steward these cases are included in Table XXIV under the month of onset.

It will be seen from Table XXV that the dockyard and Maltese contribute no less than 10 of the cases since June, and as a matter of fact the persons under treatment for this disease in Bighi have for the few months preceding November been drawn almost exclusively from these sections of the Naval population.

When contrasting the incidence of the disease this year as compared with 1905, it must be remembered that the figures for the present year include cases which have developed while at home or on passage there, and also cases not sent to hospital, whereas in 1905, except in a very few instances, only those cases returned from Malta and Gibraltar are taken into account and practically none which have not been sent to hospital. Comparing the cases only which have occurred on the station, a total is given of 174 from June to December, 1905, as opposed to 47 for the same period in 1906.

But there is yet another way in which the cases this year may have been over-estimated, inasmuch as there are quite a number included in the returns in which there is justification for some doubt either as to the diagnosis or as to whether the attack was really the first manifestation of the disease. This applies to four cases occurring in one ship at the end of June and one in another ship about the same time, in which no reaction was present very shortly after discharge following a very brief illness. These cases are further referred to on p. 84. Two cases in June were diagnosed on clinical grounds alone, and one was admitted to be doubtful. An eighth case had been constantly on the list at intervals for months with rheumatism or febrile attacks. A ninth, although he gave a reaction in his ship up to 1 in 20, showed no trace either at Gibraltar or Plymouth hospital, and was returned from both as Fever, S. C. Another man had been notified from his ship as giving a positive reaction during a short febrile attack in July, 1905, and may possibly, therefore, have been a relapse.

Incidence of the Disease in Bighi Hospital.—Even more noteworthy than all this, however, is the alteration that has taken place as regards the incidence of the disease in the Royal Naval Hospital at Bighi. It has been shown that since April 9 the sterilisation of milk may be regarded as reliable. Chart 5 and Table VIII show that, of the patients suffering from other illness in Bighi during the first quarter of 1906, 28 subsequently, within three months of discharge, developed Mediterranean Fever, but that this has not occurred in a single person who has been admitted since. As a matter of fact, among patients

resident in Bighi and subsequently developing the disease, no one shows a later date of discharge than April 16, seven days after the more stringent regulations with regard to sterilisation came into force, and in that particular case symptoms developed within three days. No other individual suffering from an attack has given a history of previous residence subsequent to that date, and, simultaneously, *there has been a total cessation of cases definitely contracted while still in hospital.*

This contrasts markedly with 1905 and the first quarter of 1906. Yet Table VIII, which illustrates this, also shows that, although the number of cases of other illness was comparatively small, there were at least quite as many long residence cases admitted in the second as in the first quarter and, given corresponding conditions, a number should have contracted the disease. Nor can the diminution in the amount of infective material be put forward as the explanation, since Chart 5 shows that in April and May, although no cases were contracted, there were quite as many Mediterranean Fever cases in residence as in the earlier part of the year.

Although no definite case has developed in Bighi since the first quarter of this year, the following three cases are quoted because they represent the nearest approach to it that has occurred, and also because they illustrate the fact that, as stated on p. 246, a reaction may be present in Englishmen who have never shown symptoms.

R.P., stoker, was admitted to Bighi on September 5, 1906, with gonorrhœa, which was contracted at the Marsa on September 1. He showed no symptoms suggesting fever until the 28th, 22 days after admission, when he had headache and temperature lasting for two days. On blood examination, he was found to give a good reaction in a dilution of 1 in 10, but not in any higher dilution, and this condition persisted during the numerous blood examinations made before he was discharged, but without any recurrence of symptoms, and there has been no sign of illness up to the end of the year. He was in hospital during 1905 for a considerable time. Although it cannot be denied that this was possibly Mediterranean Fever, the progress of the case and the nature of the reaction is decidedly against this view and the medical officers of the hospital did not regard it as such. Another man admitted about the same time with typical symptoms of gonorrhœal rheumatism and iritis, whose blood was sent up more as a matter of routine than anything else, was found to present a precisely similar reaction. In this case there was no question of contraction in hospital, and the illness was also in all probability not Mediterranean Fever. An officer suffering from septic poisoning showed a similar reaction, but in his case a recent attack accounted for it. It cannot be said that these three afford any evidence for retracting the statement made above, that no definite case has been noticed since April.

Another point in favour of the view that the measures instituted this year have had an effect on the incidence of the disease is that while the Army ratio has fallen, no marked alteration is shown up to September among the civil population for whom no corresponding preventive measures have been taken.

Conclusion.—The reductions would therefore seem to have been greater than appears at first sight and the history, especially as regards Bighi, points strongly to the precautions taken in connection with milk as mainly contributing to this, while the evidence derived from a comparison of the ratios in the Service and civil populations argues in a like direction.

SECTION C.—PERSONAL INVESTIGATIONS.

I.—The Prevalence of Mediterranean Fever in Separate Ships During 1906.

Battleships.—All the battleships on this station belong to the same class and possess several characteristics in common. Accommodation for the men is not particularly good, and in bad weather they have to sleep in the lower parts of the ship where ventilation is very defective, but in this respect none of this class are as badly off as cruisers like the "Leviathan," which suffers far more severely from overcrowding. The men's latrines are on the upper deck, but the sick bay w.c., into which most of the infective excreta are emptied, opens directly out of the sick bay.

Milk Supply.—While at Malta, fresh milk was supplied to all these ships for officers' messes, and in the case of the "London," "Implacable," "Irresistible," and "Venerable" for the sick bay also. The "Bulwark" and "Formidable" used tinned milk in the sick bay, while the other two ships, the "Queen" and "Prince of Wales," left for England to recommission early in the year, and were for so short a time on the station that they are not taken into account. There were strict instructions with regard to the boiling of milk in all cases, but in at least one ship, when the ortol test was first made use of in May, milk, supposed to be boiled, both for gunroom and wardroom, was shown to give the characteristic reaction.

Disinfection in Cases of Mediterranean Fever.—The process adopted varied greatly in different ships. In the "Irresistible," which contributed more cases than any other ship, not only were the excreta and also the sheets and bedding disinfected, but the w.c. was fumigated, while in the "Implacable," which also contributed a considerable number of cases, no very special precautions were taken in this direction. In the "London" everything was disinfected, and in the "Bulwark" only the excreta and sheets, etc., but not beds.

Hawkers of food stuffs were only allowed in one of these ships and in that case it was confined to fruits and aerated waters.

H.M.S. "Bulwark."—This ship is the flagship of the Commander-in-Chief and has an average complement of about 829 men; she was recommissioned on January 3, 1905, and most of her crew therefore have been from one to two years on the station.

Movements.—She was continuously alongside the dockyard wall or in dry dock in Malta from October 31, 1905, to February 5, 1906, and five days later left with most of the fleet for a cruise during which she touched at Gibraltar, Genoa, Aranci Bay, Naples, and Corfu, and returned to Malta on April 19. From May 2 to 5 she went to Platea and left that place for Phalerum Bay on the latter date owing to the Turkish frontier dispute, returning again to Malta on May 25 and remaining until June 5, when she again left with the rest of the Fleet for the grand manœuvres, her headquarters then being at Gibraltar. Another short stay was made at Malta from August 4 to 13 and a cruise up the Adriatic and to Argostoli followed, a final return to Malta for the winter being made on September 30.

Incidence of Cases.—Three first attacks and also three relapse cases occurred in January, one in March, three in May, one in June, one in July, and two in October. The principal point of interest about them consisted in the grouping that was exhibited. One patient, who became ill on January 19, belonged to No. 43 Mess, a second three days later came from No. 47, two tables further along on the same side of the ship, but the first of these was in Bighi, from November 13 to December 8, with gonorrhoea, and probably contracted the disease there. Another, on March 19, belonged to No. 45, situated between these two, and this man had been in hospital from February 1 to 9 with what was diagnosed as influenza, but may have been the initial manifestation of Mediterranean Fever, as he had given a doubtful reaction in 1 in 10 dilution while there. A second man from Mess 45 went sick on May 8; he also had been in hospital from January 24 to February 9, but in this case with ulcer of the foot, and had very likely contracted the disease there. On June 2 yet a third man from Mess 45 became ill. One curious feature about these cases was that two showed unusual symptoms in the shape of purpuric eruption and swelling of the ankles. None of them had been ashore more than once or twice in Malta recently, but up to February 5 the ship had of course been alongside the dockyard. The marked grouping is certainly suggestive at first sight of contact or mosquito-borne infection, but, with regard to the latter, the sleeping billets of these five men were widely separated, and in two cases at least there were decided possibilities of infection while in hospital. With one exception the three relapse cases mentioned were far removed from these messes, and this exception was in a mess on the opposite side of

the ship. All the affected messes were close alongside the seamen's galley, but the officers' galley where the fresh milk would be taken was further aft in the next compartment.

It is likewise interesting to note that from the end of May, when the ortol test was adopted, up to December 7, only four cases occurred. Three were living ashore, one an officer, two domestics, and the fourth (also an officer) appears to have been a somewhat doubtful case.

The apparent dependence on stay in Malta is also to be noted, no case having occurred after July 17 until return in October.

H.M.S. "London."—This ship has an average complement of about 740, and as she was commissioned on April 6, 1905, the majority of her crew are also in their second year on the station.

Movements.—On January 4 she left Malta for a cruise to Genoa, Civita Vecchia, and Naples, arriving at Malta again on January 31, and next day going alongside the dockyard, where, or in dock, she remained until April 24, when she moved out to moorings in Grand Harbour. From May 5 to 23 she accompanied the fleet to Phalerum Bay, and from June 5 to July 28 to Lagos for manœuvres. On the latter date she again returned to Malta and remained till August 6, when she left for the Adriatic cruise, finally returning on September 30. This ship was, therefore, during the earlier part of the year, longer exposed than the majority of the others to the possibility of infection at Malta.

Incidence of Cases.—The first case of the year fell ill on January 24; he had recently been in hospital from October 14 to December 1 with sore throat and rheumatism. The second case followed on February 4, three days after going alongside the dockyard. Nine days later a third man first felt ill, and on February 17 a fourth. The next case began exactly a week later, on February 24, and the next, a marine gunner, on March 13. Both these latter were discharged cured at the beginning of April and rejoined the ship. The next case that occurred had been in hospital from January 1 to February 9, and was put on the list on March 31. On April 24 another marine gunner began to feel ill; he had been messing with the man already mentioned as having been discharged cured from hospital since April 6. A Maltese stoker who lived ashore at Cospicua began to ail about May 12, and the next case, an ordinary seaman who had been in hospital for two months until April 7 with psoriasis, commenced to feel ill on May 14. Since that time there have only been two rather doubtful cases and one attack in a Maltese domestic.

The two doubtful cases were the captain's steward—who was sick on board from July 18 to 28, and gave a reaction with a dead culture, but in whom no trace of a reaction could be obtained when his serum was examined on August 1 in the Commission Laboratory—and a midshipman, who was sent on June 23 to Gibraltar Hospital for appendicitis, and was invalided as Mediterranean Fever, but the diagnosis was made on clinical grounds, no reaction having been obtained.

The Maltese domestic became ill a few days after the ship left Malta in August.

Of the 13 possible cases, therefore, three had recently been in hospital and two were Maltese, while of the others two were doubtful. Six occurred in close relation to the period during which the ship was in dock or alongside, of whom only one had been in hospital. Two of the others, however, were marines, and it is to be noted that the marines of this ship were at Ghain Tuffe Rifle Range from February 12 to 27 and March 3 to 12, and that one of the two attacked had been sleeping there up to March 10. Four of the 13 patients attacked were marines, but these cases were widely separated in point of time, and with the one exception already noted there was no attempt at grouping.

Possible Sources of Infection.—The blood of 28 of the permanent Maltese was kindly sent by Fleet-Surgeon Hadden to the laboratory, and one was found to react up to 1 in 50. A man who was the manager of the canteen began to ail about April 1, and eventually died at his home ashore of what was returned as Mediterranean Fever; he may have been ill for some time on board. The blood of both the men who were discharged cured from hospital was also examined, but neither gave a reaction.

H.M.S. "Implacable."—This ship has a complement of 742 men and arrived on the station on September 17, 1904, after recommissioning, and since that time has had over 20 cases of Mediterranean Fever, so that she has been one of the ships more severely attacked.

Movements.—She arrived at Malta from Corfu on January 5, 1906, and remained at moorings in Grand Harbour until February 10, with the exception of 14 days in dock, from January 25 onwards, when she left for the Lagos cruise. She returned to Malta, however, on March 13 to have her fire control fitted, and was in dock and alongside for that purpose for 24 days. On April 6 she left for Corfu, returning on the 19th, and during this trip took away the six dockyardsmen who were at work on fire control. She only remained four days on this occasion and then went to Platea until May 5, when she accompanied the fleet to Phalerum Bay. On her return she spent five days at Marsa Sirocco, and finally reached Grand Harbour on May 30. On June 5 she again sailed for the manœuvres, and while absent on this occasion proceeded to England to recommission, and since that time has contributed no cases of Mediterranean Fever, so that all remarks deal with the old commission.

Incidence of Cases.—Four cases were admitted from this ship on January 1, of whom one had just previously been in hospital with rheumatism, and one was a Maltese domestic. The onset in all was about the middle of December. A fifth case became ill on January 14, and another on February 20, but this latter patient had been discharged

from hospital on December 13, after enteric, and had probably contracted the disease there. He was an engine-room artificer. While the ship was at Malta, after March 13, two men, one the sick berth steward, suffered from attacks, the diagnosis being later verified by blood examination in the Commission Laboratory. The sick berth steward did not go on the sick list. Both had quite recently been in hospital. On the return of the ship from Corfu on April 19, five more cases were sent to hospital, but one of these was a relapse in a man who had rejoined the ship on March 13. Three of the remaining four had been recently in hospital, and probably contracted the disease there, the dates of onset being March 24 and April 3 and 16 respectively. The fourth case was an artificer belonging to the same mess as the first one, and the date of onset in his case was also April 16. Two gun-room artificers next became ill on April 23 and 25 respectively; the second had, five months previously, been in hospital with an ulcer.

Of the 14 cases in this ship, therefore, seven had been in hospital within three months of other illness, two were officers, and one a Maltese. Two belonged to the gun-room and two to Mess 55, one each to Messes 57, 59, and 61. The others were widely scattered.

Possible Sources of Infection.—The relapse case was on board from March 13 to April 19, and after his second admission on that date his urine was plated out on more than one occasion both at Bighi and in the Commission Laboratory, but without recovering the Micrococcus. Two other men were suffering from the disease on board, one becoming ill on March 13, the other on March 17, and one of these was not on the list. Six dockyardsmen were on board, living in a casemate, from April 6 to 19, and had been working on board since March 13. The blood of five of these was obtained, and one gave a reaction in both 1-per-cent. and 2-per-cent. dilution, but not a very marked one, and one other in only 1-per-cent. dilution. Eight dockyardsmen, including three of the preceding, were working on board from April 21 to May 29, but none of these gave a positive reaction. Of 11 who were left in the ship on June 5, all but two had been included in the previous parties, the man who gave the reaction in both dilutions being one of them. Neither of the two fresh men reacted. Twenty-eight of the permanent Maltese in this ship were also examined and one only was found to give a reaction, this being the domestic who was admitted to hospital for Mediterranean Fever on January 1.

It is evident, therefore, that in this ship there were an unusually large number of possible sources of infection, while a certain degree of grouping was noted, but the fact that so large a proportion of those who were not officers or Maltese had recently been in hospital rather discounts the value of this as an evidence of contact infection. The case which pointed most strongly in this direction was the second artificer, who

had been working with the party of dockyardsmen, two of whom reacted.

H.M.S. "Irresistible."—This ship, which also has an average complement of about 740 men and was in her second year on the station, suffered during 1905, as already detailed at p. 66, more severely than any other battleship, principally during a long stay in dock.

Movements.—From January 1 to 27, 1906, she was cruising between Patras, Platea, and Corfu, and on the latter date arrived at Malta, where she remained moored in Grand Harbour until February 10. She accompanied the rest of the fleet for manœuvres at Lagos, and later went with the flagship to Genoa, Aranci Bay, Naples, and Corfu, returning to Malta on April 19, and remaining in Grand Harbour till April 30, when she left to carry out firing, and went on with the others to Phalerum Bay. She returned on May 22, but left at once for Marsa Sirocco for two days, and on coming back to Grand Harbour went into dock from May 28 to June 1. Like the other ships, she left again on June 5, but returned on July 29 and once more went into dock for a further period of six days, leaving on August 6 for the same cruise as the flagship. It will be seen, therefore, that her men have had comparatively few opportunities of leave in Malta since February.

Incidence of Cases.—Two patients, a warrant officer and a stoker, became ill on February 20, 10 days after leaving Malta, and a marine gunner the next day. All three had been quite recently in hospital, and probably contracted the disease there. Three more were sent to hospital on her return to Malta on April 19, one of these being a relapse case, and the other two having become ill on April 1 and 16 respectively. Both had been in hospital, one until the ship left Malta, while the other had not been discharged till February 19, and had waited some time in the "Egmont." In the first case, therefore, the onset occurred some 40 days after departure from Malta. The next case, an officer who had been in hospital for operation on the knee joint, first felt ill on April 12, a month after discharge; he had been living ashore during the interval.

Up to this time, therefore, every case, without exception, had recently been in Bighi suffering from other illness, but after this, although this ship was the only one which returned any considerable number of cases subsequent to the departure of the fleet on June 5, only one of these had previously been in hospital, and he before April. A marked grouping was, however, met with in this second series of cases. The first of these, a chief petty officer, began to feel ill on June 2, but was not placed on the list till after she left for the cruise. A second man, belonging to Mess 26, which was separated from the chief petty officers' mess by a water-tight compartment, communicating by a door, first began to ail about June 6. An able seaman, living on a different

deck, was the next to feel ill, the onset in his case being about June 23, and he gave a history of hospital residence from February 3 to March 21. A fourth man, belonging also to Mess 26, first had symptoms on June 26, and next day a chief petty officer with his mess in quite a different part of the ship also began to ail. The day after this a chief stoker, who had up to June 21 also belonged to Mess 26, was put on the list, but this man said he had been feeling off colour for months. The last man belonged to a different mess altogether, and his symptoms began on July 14, or rather more than a month after leaving Malta.

Since that time only one case has occurred, the sick berth attendant, who first complained on August 8, two days after leaving Malta on the next occasion. This man was on the staff at Bighi until May 4.

Mess 26 and the chief petty officers' mess next to it were closely adjacent to the sick bay, so that of the eight cases occurring after June 5 no less than five came from one very limited portion of the ship. Propinquity to the sick bay offers, therefore, a possible source of infection, but the man who first felt ill did not go on the sick list as soon as the second, so that two out of the five occurred before there was any known source of infection there.

It is also a curious fact that four out of these eight cases were only ill about three weeks, and that when their blood was examined in the Commission Laboratory on August 1, very shortly after their discharge from the sick list, not one of them gave the faintest trace of a reaction. Surgeon Macleod, who was kind enough to give information on the subject, states that the symptoms were in all cases quite characteristic, that the reaction was undoubted in each case, and was repeated more than once, and that a control showed no reaction. The culture was, however, an old one, and as none of the patients have since shown any sign of recurrence of symptoms, some small amount of doubt as to the nature of the illness may perhaps be permitted. Anything suggesting criticism of the results obtained by competent observers who have, moreover, had the advantage of studying the actual symptoms is to be avoided, but as the culture used was an old one it may at least be regarded as rather a curious coincidence that no less than four cases occurring at the same time should be of such short duration, have no sequelæ, and within a month fail to give a trace of agglutination even in low dilutions. At the same time the fact that the remaining cases, which were more severe and necessitated invaliding, have all been confirmed by examinations made at the home hospitals must be regarded as evidence in favour of the four specified above being cases of the disease.

There was another possible source of infection in this group of cases, inasmuch as several dockyardsmen who were in the ship during this

particular cruise fitting fire control were accommodated in the casemates just alongside these messes. Accordingly, on the return of the fleet, the blood of six out of the total of seven of these men was obtained and tested, but no reactions were obtained. The blood of 28 of the permanent Maltese on board was also obtained and tested, and one was found to react. Of the five men composing the group, two slept in their messes, and the sick berth attendant in the sick bay, the rest elsewhere. Once again, therefore, the evidence, on the whole, points to some cause operating in the daytime rather than at night.

H.M.S. "*Venerable.*"—This, the flagship of the second in command, has been on the station since September, 1905, and her average complement is about 770.

Movements.—She was at Naples on January 1, 1906, whence she proceeded *viâ* Port Augusta to Malta, arriving on January 9, and remaining at moorings in Grand Harbour till February 10. On that date she left for manœuvres at Lagos, but did not return with the rest of the fleet, as she proceeded on March 8 to Chatham to receive a new admiral. She left England on March 30 and arrived at Malta, after calling at Gibraltar, on April 7. Three days later she went into No. 4 Dock, and remained there or alongside the wall till June 5, when she left for manœuvres. Her later movements correspond with those of the "Bulwark."

Incidence of Cases.—Very few cases are recorded this year. One man developed the disease while resident in hospital on January 7. A midshipman was sent to hospital on January 19 for what was at the time diagnosed influenza, but as he showed a doubtful reaction and later developed Mediterranean Fever it is probable that this illness was the first manifestation of that disease. An E. R. artificer who was sent to hospital on April 10 for removal of tonsils developed suspicious symptoms nine days later, and once reacted in a dilution of 1 in 50, but this was the only positive result in numerous examinations, nor could the organism be recovered from his blood or urine. This case has not been included in the returns. A fourth man, an ordinary seaman, developed the disease on April 18; he had been in hospital till March 27, and just before discharge showed suspicious symptoms, but gave no reaction. The disease was probably contracted there. Since then the only case that has occurred was another ordinary seaman who first felt ill on June 29, 24 days after leaving Malta. Very little information is available about this case.

H.M.S. "*Formidable.*"—This ship provided no case throughout the year. She belongs to the same class as the others and recommissioned on October 1, 1904, her complement averaging about 740 men. Since commissioning she has only had about seven cases, although in 1905 she was in dock or alongside for a period of 124 days. Her last

case occurred in December, 1905, and she remained on the station till August 13, 1906. It is interesting to note that her medical officer is inclined to ascribe this immunity to the practice of rarely sending a case to hospital except for invaliding. He further stated that tinned milk only has been used in the sick bay, and that mosquitoes were rarely seen.

H.M.S. "*Queen.*"—This battleship went home to recommission in April, and since her return has not provided a single definite case, although one officer sent to Gibraltar Hospital was so diagnosed, but only on clinical grounds. Before her return to England four cases had occurred, of whom two had previously been in hospital.

H.M.S. "*Prince of Wales.*"—This ship also left the station in May to recommission, and remained there till well on in the year. She has not provided any cases since her return, but before going had had two, one of whom had been recently in hospital, while the other was contracted while resident there.

Cruisers.—There are four first class and three second class cruisers on the station, all the latter being sister ships. The first class cruisers are all recently built and well up-to-date in equipment, but the "Leviathan," which is much the largest of the four, carries more men than any ship on the station and suffers much more from overcrowding and defective ventilation. Ships of this class nearly always have a heavy sick list, while wounds are apt to become septic, and there is much sore throat.

The accommodation in the "Lancaster," "Suffolk," and "Carnarvon," is much superior, and the latter, which is larger than the other two, is fitted with a bakery and the most up-to-date arrangements for cooking. The three second class ships are also very comfortable, and the accommodation is on the whole good, and ventilation, owing to their smaller size, is more satisfactory. They are employed on the outlying parts of the station and are comparatively rarely at Malta. The latrines in all these ships are on the upper deck, and in all there is a w.c. opening directly out of the sick bay, into which most of the excreta from the sick are discharged.

Milk Supply.—Fresh milk has been used for officers in all these ships except the "Suffolk," the ward room officers of which ship, I believe, voluntarily gave up the use of it shortly after arrival in April. It has also been made use of in the sick bay in all but the "Suffolk" and "Venus." In one of these ships at the end of May it was found unboiled, despite orders to the contrary.

Disinfection.—There have been no cases in the "Suffolk" and "Lancaster" since recommissioning, and no information is therefore available on this point. In the "Venus" during her last commission, besides the ordinary measures relating to excreta, clothing, etc., after the occurrence of a case of Mediterranean Fever, the fixtures in the

sick bay were removed, the place scrubbed with perchloride of mercury lotion and then repainted. In the "Carnarvon," "Diana," and "Minerva," excreta, clothing, and bedding were disinfected, but in the "Leviathan" only the excreta.

Hawkers of food stuffs were only permitted in the "Leviathan," which has contributed practically no cases.

H.M.S. "Leviathan."—This, the flagship of the cruiser squadron, has an average complement of 908, and has been on the station since December 12, 1905.

Movements.—She was in Malta until February 10, being alongside the dockyard until January 22. She accompanied the fleet on February 10 and returned to Malta again, on April 20, till April 30. On May 5 she merely returned in order to proceed to Phalerum Bay. On her way back from the latter place she called at Port Said and Alexandria, and only arrived in Malta on May 28, leaving again on June 4. She was one of the four ships that came in again on July 28, and she sailed for the Adriatic cruise on August 3, not returning again till September 30.

Incidence of Cases.—With the exception of one Maltese domestic who had a relapse on December 18, 1905, the only cases have been two which occurred in March in men who had been in hospital and were waiting in the "Egmont," one stoker who first felt ill on April 24, and a ward-room officer who noticed his first symptoms on June 19. There was no possibility of connection between any of these.

H.M.S. "Carnarvon."—This ship has a complement of 636 and has been on the station since June, 1905. She was in Sliema harbour in dockyard hands until February 10, and then proceeded on the Lagos cruise and afterwards by herself to Marseilles and Greece, not returning to Malta till May 3, and then only stopping two days before leaving for Phalerum Bay. She came back again on May 25 and went into dock from June 1 to June 5, leaving on that date for manœuvres. She also returned on July 28 and remained till August 4, her subsequent movements corresponding with those of the "Leviathan." This ship was, therefore, almost altogether absent from Malta between February 10 and October 1.

Incidence of Cases.—Three cases occurred in February, one on the 10th and two on the 20th; all had recently been in hospital. A relapse case occurred in one of her Maltese on February 25, and on March 15 a stoker who had been discharged from hospital on February 9, after an attack of gonorrhœa, also first felt ill. These were all the cases that occurred during her first absence from Malta, but after the short stay she made in June, one case felt ill on the 21st, 16 days after leaving, and a second on July 11, or a little over a month. A third case was put on the list on July 15 with rheumatism,

but was found to have Mediterranean Fever after admission to Bighi on July 30. This man had been there previously from November 3 to January 31 with enteric, and since discharge had already been on the list three times for periods of a few days with febrile attacks and rheumatism. The chances are therefore in favour of this attack having been originally contracted in hospital and of its having existed since March, at which time he had his first bout of sickness. One more case occurred in this ship on August 8, four days after leaving Malta, the patient being a gun-room officer. The attack was not a severe one. Of the total of eight, therefore, five were probably contracted in hospital and one was an officer. The sleeping and messing billets of the last cases were in entirely different parts of the ship and there was no reason to suspect any relation between them.

H.M.S. "Lancaster" and "Suffolk."—Both these ships have complements of about 680 men, both recommissioned at about the end of March, and neither has contributed a single case since arrival on the station. They were practically always with the fleet, and have therefore been in Malta on three occasions for 10 days or so previous to October.

H.M.S. "Venus."—This ship has a complement of about 419, and has been in commission since February 7, 1903. She left the station early in May to pay off, and did not return till August 4. She has been largely employed in Cretan waters. She was in Malta from January 1 to 31, and up to the 24th was in dock. She then left for Crete and remained there till May 1, when she returned to Malta and a week later sailed for England to recommission. She came back to Malta on August 2 and remained till the 19th, when she proceeded to Port Said and was there until November.

Incidence of Cases.—No case had occurred in this ship from July, 1905, until after she had been in dock. Then a Marine private went on the list for three days on January 21 and again on March 27 for 51 days; a second Marine was put on the list on January 29 and was 59 days under treatment. A third Marine first complained on February 12, and a fourth on April 6, and finally an able seaman was admitted to Haslar on May 17. At first sight, therefore, this would appear to give an excellent illustration of the effects of docking, but a more detailed examination does not bear this out. First, the Marines were at Ghain Tuffieh rifle range from January 11 to 27, or rather more than half the time the ship was in dock, and, as a matter of fact, the first case was sent in from there, and the second went sick two days after returning. The third case had been in Bighi from October 10 to November 13, 1905, with what was returned as functional heart disease, but as he gave a doubtful reaction during this stay, and the course of the case rather suggested Mediterranean Fever, this may have been the first manifestation of that disease.

This man was a ward-room servant and had drunk milk, probably unsterilised, on board. The able seaman was in hospital for the whole of January and was therefore not at all exposed to the possibility of infection in dock. This effectually disposes of docking as a factor in the causation of this group of cases.

The rifle range at Ghain Tuffieh is so isolated that the presence of infected mosquitoes is most improbable, and in fact mosquitoes are said by the officer in charge to be practically non-existent there. The possibility of contact infection from the third case, who may have been the subject of the disease all the time, cannot be altogether ignored, but, unfortunately, neither of the first two cases were seen, and no information could be obtained with regard to their relation to him.

Since the ship recommissioned there has been only one case, an officer who was discharged to the "Egmont" on August 18 to await passage home, and left on August 26 in the s.s. "Formosa." He complained of illness the day before leaving and died in the Seamen's Hospital, at Greenwich, on September 26, of Mediterranean Fever.

H.M.S. "*Minerva.*"—This ship commissioned in June, 1904; she has an average complement of about 420. She was in Egyptian waters for the first five months of the year and only arrived in Malta on June 1. She went into No. 3 Dock from June 8 to 15, leaving on the latter date for manœuvres. Mosquitoes were much complained of while in dock. She again arrived in Malta on July 24 and on the 30th went alongside the dockyard for some days. On August 20 she sailed for home to pay off.

This ship will be seen to have a larger proportion of infected persons among her Maltese than any other examined, and she has also spent a good many days in Malta during the hot months. She has not, however, contributed a single case of Mediterranean Fever.

H.M.S. "*Diana.*"—This ship has an average complement of about 400 and was commissioned on September 30, 1904. She was lying in Egyptian ports and Akaba in the Red Sea all the first part of the year until May 22, when she sailed for Malta, arriving on June 1 and going into No. 4 Dock from June 6 to 15, when she also left for the Atlantic manœuvres. Mosquitoes were more complained of in this ship than in the "Minerva." She returned to Malta on July 24 and August 9 for two short periods, of two and five days respectively, before the Adriatic cruise. Her last stay at Malta dated from September 14, and three days later she went alongside the dockyard until October 9, finally sailing for England to pay off on October 12.

Three cases occurred on board in the latter half of last year, but the only one in the first half of the present year was the case which is given in detail on p. 246. The next case, the master-at-arms, began to feel ill about July 19, or some 35 days after leaving Malta and

coming out of dock. He had been ashore at Gibraltar, but not elsewhere. A third case first complained on June 22, but this is a doubtful one, as his blood gave no reaction after leaving the ship. A fourth case has been returned from Plymouth hospital as commencing on October 10, but no further details are available.

SMALL SHIPS :—

H.M.S. "Barham."—This ship, a third class cruiser, arrived on the station in May, 1906, to relieve the "Sentinel," and has not contributed any cases.

H.M.S. "Surprise."—This is the Commander-in-Chief's yacht and has been out on the station for many years. She has a complement of 107 men and was last recommissioned on February 21, 1905.

Movements.—She was in dock or alongside from December 5, 1905, to January 19, 1906, but since that time has only been in Malta for very short periods, except from May 25 to June 14. Her next visit was from August 2 to 5. Owing to her small size she is moored close to the shore and her officers state that mosquitoes are nearly always troublesome on board. Her usual billet this year has been in Dockyard Creek close alongside Senglea, so that she is really in closer relation to the houses in that place than are ships in dock on the other side.

Up to August 23 no case had occurred in the ship, although two of her men during the time she was in dock contracted the disease while in Bighi for other illness. On August 23 her engineer officer was taken ill, and on November 3 one of her lieutenants was sent to the "Maine" hospital ship. The latter officer, however, had been ill for some time and the onsest of his illness is returned from Haslar as July 21. No other cases have occurred, and although this is rather suggestive of a contact infection it is curious that officers should as usual be singled out for attack, since the nearness of the shore to the anchoring billet occupied by this ship when in Malta affects officers and men alike.

H.M.S. "Vulcan" and the Destroyers.—The "Vulcan" is now the parent ship of destroyers and has a complement of about 448 men; the crews of the destroyers bring the total to about 1180. She has been 12 years on the station, but was recommissioned in March, 1905. Her sick bay accommodation has not only to be used for her own men, but also for the crews of her satellite destroyers and in consequence is entirely inadequate, so that an extra sick bay has constantly to be screened off on the main deck and any severe case is as soon as possible transferred to hospital. Her latrines are also entirely peculiar to herself, as they are on the main deck and not the upper deck, but are approached from the latter by a narrow and tortuous ladder, and, being also much sub-divided by partitions, are exceedingly badly ventilated, almost impossible to keep clean and dry, and

abominably malodorous. One would expect that if inoculation from infective excreta plays much part in the production of the disease among the barefooted seamen that it would find its best opportunity in this ship. The galleys too are close to the sick bay.

Milk Supply.—Fresh milk is supplied both for officers and sick bay.

Disinfection.—This is not a routine measure in case of Mediterranean Fever.

With the exception of the period between January 18 and 26, when she made a cruise to Gibraltar and back, this ship did not leave her moorings in Lazzaretto Creek until February 14. In this billet, where she lies surrounded by the destroyers, she is not very far from the beach, which is on the Lazzaretto side, a favourite breeding place for *Acartomyia Zammittii.* On February 14 she went round to Grand Harbour, and on March 7 went into No. 4 Dock for five days. On April 6 she left for Corfu, but returned again on the 18th to the Lazzaretto Creek, where she remained until May 5. She then took part in the Phalerum Bay demonstration, once more returning on May 21 and sailing again on June 5 with the fleet. She subsequently made a stay at Malta from August 25 to September 6 and returned for the winter on the 30th. She was therefore in Malta for the greater part of the first half of the year, and has been longer there than any other big ship.

During the first four months of this year there was a constant succession of cases, no less than 14 occurring, but since April 22 no single case has occurred among persons actually belonging to the ship herself. In the first of these cases the onset was December 24, the next January 18, then there was one on February 8, two on the 17th, another two days later, and two more on February 20. The next man had his first symptoms of Mediterranean Fever on March 12, but this was contracted while in hospital, so that no cases really occurred in the ship in March, and the onset of the next was April 1, when two first felt ill. Two more had their first symptoms on April 10 and the last on the 22nd. It has already been stated that one of these 14 actually contracted the disease while in hospital, but even more interesting is the fact that every one of the others without exception had been in hospital for other diseases within the three months preceding onset, the interval being under a month in five cases, under two months in five, and under three months in the remaining three, while the diseases from which they suffered were either venereal or surgical in 11 out of the 13. It is a very suggestive fact that a ship which is constantly obliged to send patients to hospital and also frequently contributes cases of Mediterranean Fever should have had an unusually large number in the early part of the year, all of whom had been in hospital, and that since the certain sterilisation of hospital milk, should have totally ceased to contribute cases, notwithstanding a fairly lengthy

stay in Malta. It points strongly not only to the hospital as the place of contraction, but to the milk as the vehicle of infection.

That being so it is interesting to find that in this ship also there is quite a marked grouping among the cases. Thus Mess 17 shows two, and Mess 15 another, while three belonged to Mess 23, and two more who fell sick on the same day to Mess 25. The sleeping billets of all in whom information was obtainable were widely separated.

Destroyers.—It is quite impossible to enter in any detail into the movements of destroyers except to say that as a rule the majority accompany the parent ship and that they are moored in Sliema Harbour close to her. A proportion of them are almost constantly in dock, under which circumstances a nucleus crew only is left on board and the remainder hulked in the "Cruiser" or turned over to another destroyer. Owing to the paucity of accommodation for the sick in the "Vulcan" they are usually sent to hospital when ill.

Twenty cases have occurred among their crews during 1906, and of these four first felt ill in January, two in February, four in March, four in April, three in May, one in June, and one in August. The last case had been notified as giving a positive reaction in his ship during pyrexia of about a week's duration in July, 1905, so that this was possibly a relapse. With four exceptions, including the case just mentioned, all had recently been in Bighi with other illness, but in two instances at a period more remote than three months. Of the remaining three who had not been in hospital, two were officers, and one of these was the June case and came from a destroyer which was alongside at the time. Just as with the "Vulcan," therefore, the occurrence of cases has greatly diminished coincidently with the certainty of sterilisation of milk in hospital.

Two ships provided three cases each, and three two cases each, but these showed no evidence of any connection, and some of them were almost certainly contracted in hospital.

Conclusions.—The period under consideration is too short, and the cases too few, to justify any definite conclusions, but so far as it goes it may be held to suggest:

(1) That defects in accommodation and ventilation and the prevalence of ailments resulting from these do not appear to exercise much influence.

(2) That duration of stay on the station appears to be of more importance, but that there are constant exceptions. Judging from the histories of the "Implacable" and "Irresistible," where a ship begins badly she tends to go on in the same way, and the converse is illustrated by the "Formidable."

(3) With very few exceptions, cases go on the list within six weeks of leaving Malta, and ships which are much away do not provide cases until after their return as a rule.

(4) Just as was found by Colonel Davies, there seems to be no relation between the completeness of the disinfection carried out and the occurrence of cases.

(5) The grouping shown would be more suggestive of mosquito or contact infection if so many did not show a previous hospital history and if it related to sleeping billets as well as to messes.

II.—Facts Elicited by the Study of Individual Cases.

In addition to the information derived from cases personally investigated, a considerable amount was available from forms which had been distributed in the fleet in 1905, and sent to my predecessor, or Staff-Surgeon Shaw, on the occurrence of a suspected or developed case of Mediterranean Fever.

Chiefly owing to differences in the speediness of diagnosis, these vary considerably in the completeness of the information recorded, and, accordingly, to almost every question there has been a differing number of answers.

The evidence in this part of the report is therefore derived from three sources—first, cases personally interviewed, 70 in number, including 48 from the Service afloat, 9 from the hospital, 8 from the dockyard, and 5 Maltese; secondly, a certain amount of information collected about 13 cases not personally interviewed, which occurred in ships away from Malta and never returned there; and, third, the information obtained from the forms referred to above. Where there can be no doubt as to the accuracy and completeness of the evidence provided, these will be combined, but otherwise they will be treated separately.

It is almost unnecessary to say that this part of the enquiry has been much interfered with by the continued absence of the fleet from Malta, and by the very gratifying decrease which has latterly taken place in the number of cases.

For obvious reasons connected with the difference of environment, these cases are considered under the following headings:—

Service afloat, officers and men; English civilians employed in the dockyard; Maltese, afloat and ashore; hospital residents. The facts with regard to these which have a bearing on hospital conditions have already been discussed at p. 74. For certain general considerations no such distinction is necessary, and these are therefore first dealt with.

Time on Station.—The shortest interval intervening between arrival in Malta and onset of symptoms recorded in these returns was 17 days. One case was probably only eight days, but no definite information is available. As will be seen from the next table, which, in addition to giving the duration of residence in the total number about which information was available on this point, also compares the interval

in those arriving in the hot and cold weather respectively, such a short period is decidedly the exception:—

Table XXVI.

Time in months on station......	Under 3.	3 to 6.	6 to 12.	12 to 24.	Over 24.
Those persons arriving from April to September	6	12	24	36	12
Those persons arriving from October to March	2	12	25	33	12
Total	8	24	49	69	24

Except for the period under three months, there is no evidence here that persons who arrive in the hot weather are attacked any earlier than those arriving in the winter, a fact which, in view of the way in which new arrivals suffer from the attacks of mosquitoes, rather argues against a mosquito-borne infection. It must be noted, however, that ships are more often absent from Malta in the summer than the winter.

Previous Service on Station.—Only 12 out of 52 persons who gave information on this point had previously served on the station.

In Dock or alongside Dockyard.—Twenty out of 99 cases developed in ships which had been in dock or alongside the dockyard wall within the previous 30 days, but one of these 20 was sleeping in the "Egmont." As the whole question of docking is discussed at p. 63, no further remark will be made, except to note that 10 of these had recently been in hospital.

The Presence of Sore Throat and other conditions of the Mouth which might conceivably provide opportunities for Inoculation by Micrococcus melitensis.—Only 14 out of 52 cases in which the presence or absence of sore throat was enquired into admitted having any throat symptoms, and similarly of 56 cases in which the condition of the tonsils was examined to ascertain the presence of chronic enlargement only 14 were found to be affected. The teeth were fairly good in 34, poor in six, and very bad in five. In answer to enquiries about smoking, all except five were found to smoke to a greater or less extent. The amount of evidence therefore suggesting possibilities of absorption from the mouth was not very great.

Infection from Abrasions produced on Urine-polluted Ground while playing games.—Although there does not seem to be a great probability of the recreation grounds in general use being much polluted in this way, the suggestion has been made that infection may thus occur, and the patients were therefore asked whether they had recently played in

Malta any games in which abrasions might be produced. Five out of 7 officers, but only 11 out of 44 men were found to have done so, and the probabilities are against this playing any part in the dissemination of the disease.

Facts elicited with regard to cases occurring in the Service Afloat.—In dealing with the incidence of the disease among this section of the naval population, one of the most important questions to determine is that of the possibility of the contraction of infection on board the ship itself and the various ways, if any, in which this may take place. Where a ship is lying in the stream, the methods by which persons on board are likely to be infected may for practical purposes be summarised as:—

(1) Infection by foodstuffs brought on board, and especially milk or its products.

(2) Various forms of contact, direct or indirect, with pre-existing cases, ambulatory or developed, occurring on board, and through the medium of biting flies with cases occurring ashore.

(3) Infective dust.

(4) Milk.

As milk containing *Micrococcus melitensis* is known to be supplied at times to ships, it seems by far the most probable vehicle of infection, which may occur as the result of ingestion, convection by flies to other food, or, possibly, in rare cases, by inoculation. The latter probability is not a great one as far as ships are concerned, since all officers' cooks are Maltese.

With regard to the ingestion of milk in Malta, notes were obtained of 59 men belonging to the Service afloat, excluding cases among Maltese. Thirty-five of these, including six of the Sick Berth Staff at Bighi, already dealt with at p. 56, had had milk while in hospital, and one other, at least, while on the sick list. Two more had taken it in some form elsewhere, and two had taken it, but not for a long time, one of these latter being an E.R. artificer from the "Vulcan," who was reported in July, 1905, to have given a positive reaction on board during a week's pyrexia. At that time he had been drinking milk daily in his home at Sliema, but had taken none since. Seven more men, including two of the Sick Berth Staff at Bighi, only admitted to having milk with tea, and two others, not personally interviewed, were said to have probably had milk. No notes were obtained about three cases, and seven denied having ever taken milk. As, however, of these latter, two were found to have been in Bighi recently, one for rheumatism, the other as a member of the staff, there is some reason for doubting the accuracy of this statement, which was not obtained personally. Out of 59 men, therefore, seven had milk only in tea, 42 in various other forms, and seven had none. On the other hand, of

11 officers, one had taken milk in hospital within a month of his illness, four more had had it elsewhere in various forms, and one was stated to have probably taken it. Three said they only took it in tea, but two of these had also had ice creams recently. About the two remaining cases, no facts were forthcoming on this point. Of the four who had certainly taken milk, one stated that he practically lived on it, but that it was always boiled by his Maltese servant in his house ashore, an assertion that there was unfortunately no opportunity of testing, and a second had, some three months before coming on the sick list, been trying a diet consisting of hot and cold milk alternately to the extent of about six pints a day. In no case among the officers, therefore, was there any absolute denial of milk drinking.

In the returns sent in to Staff-Surgeon Shaw the question asked was whether fresh goats' milk had been taken during the preceding 30 days. The following figures were obtained from the tabulation of these returns, cases contracted while in hospital, the Sick Berth Staff, and Maltese being omitted from the consideration :—

Among 40 patients who had recently been resident in Bighi for other illness, 38 had either had no milk since discharge, or where the interval before onset was over 30 days, for that period. Two gave a history of milk drinking, but one only in tea. The question of milk in hospital was in the majority of cases ignored, but has already been dealt with at p. 71.

Of 34 patients who gave no history of previous hospital residence seven, including three officers, had taken milk, but one only in tea, and a second had obtained the milk at Corfu.

Convection by Flies.—Since galleys and latrines are places where flies habitually congregate, and since infective material in the shape of milk is sometimes present in officers' galleys, and in the shape of urine in the latrines, especially that in the sick bay, a suggestion of the possibility of the conveyance of infective material in this way to food in messes near these special parts of the ship is not altogether unreasonable.

The relation of the affected messes to them has therefore been noted. In seven cases the mess was close to the officers' galley, and in four more to the ship's galley, three of the latter occurring in one group in the "Bulwark," as stated on p. 79. The group of cases in the "Irresistible," described at p. 84, belonged to messes not far from the sick bay and close also to the ship's head. The sick bay attendant in this ship and the sick bay steward in the "Implacable," both of whom messed and slept in the sick bay, also contracted the disease, but in their case the possibilities are, of course, more various. Out of the total of 70, therefore, 18 were in relation to these parts of the ship.

Other Forms of Food.—The sources of food, both that supplied by the

Service and by the canteen and messes, were investigated, but the only form, other than milk or its products, upon which suspicion can rest is to be found in raw fruits and vegetables. Of the 57 persons interviewed, however, seven stated that they never took either fresh vegetables or fruit, and in the majority of cases who were in the habit of taking the latter, skinned fruits, such as oranges, were the usual form.

Goat Cheese.—Only in the case of one man could a history be obtained of the ingestion of goat cheese, and it was not made use of in any ship in which enquiry was made. It may be regarded, therefore, as quite an exceptional article of diet. Butter is practically always tinned.

The Question of Hawkers.—The selling of food stuffs or drinks on board was only permitted in two sea-going ships, and neither of these had many cases of Mediterranean Fever. Milk was sold by hawkers in the "Egmont." As it was found, however, that ice creams were being sold to the men in one ship at least, a recommendation was made with regard to this, with the result stated at p. 73.

Mosquitoes.—With a ship lying out in the stream, biting flies might presumably be infected ashore, and either fly off where the ship was near the beach or be conveyed in boats with fruit or something similar. On the other hand, the possibility of their carrying infection from case to case on board must be admitted, but with prevailing conditions on a lower deck crowded with disturbing elements and subject to repeated cleansing a long stay by a mosquito in any particular part is decidedly improbable. As, however, such a method of dissemination has been suggested, it was desirable to note relationships to pre-existing cases and to possible reservoirs of infection in the shape of Maltese on board.

The grouping in three ships, which has already been discussed, refers to messes during the day, and not to sleeping billets, which in the majority were far apart. Since during the day the bluejacket is pretty constantly occupied away from his mess, such a grouping is, therefore, far more suggestive of something connected with food supply than of mosquito infection.

Out of the 70 cases 12, including two belonging to the Sick Bay Staff of ships, were found to have been in the near neighbourhood of pre-existing cases, usually in the same or adjoining mess. Eight more, while recently in hospital for other illness, had been in the same ward and in neighbouring beds to cases developing there. In the old returns contact was noted only in five cases out of 60, four of these referring to contact while in hospital. Of the personally investigated cases five more had been in near relation to Maltese on board who may have been suffering from ambulatory attacks. Two are especially suggestive, the first having two Maltese sleeping on the deck below

his hammock, and also having worked just before his illness with the dockyardsmen carried by the ship, of whom two were found to react, while the second was working on board his destroyer with several dockyard men.

With regard to direct evidence about mosquito bites, seven persons said that they were very rarely bitten, 18 occasionally, 10 frequently. Three more did not remember being bitten, but their messmates had recently complained, and 19 had neither been bitten nor heard complaints. A good many of the persons who admitted to having been attacked stated that they had been much bitten on first arrival on the station, but not so much latterly.

Taking all this evidence for what it is worth it cannot be regarded as pointing very strongly to direct contact infection or as greatly incriminating mosquitoes.

Indirect Contact.—Infected clothing or bedding. Only one man out of over 150 who were asked the question was found to have ever used any but his own hammock, and even in this case it is quite improbable that this had been used by a pre-existing case. This possibility may, therefore, be disregarded. With the exception of the Sick Berth Staff, too, practically no histories were obtained of contact with the effects of patients suffering from the disease. A very few had taken part in transferring patients to the Mediterranean Block while in hospital, or in taking bedding to the disinfector, one or two had collected the clothing of messmates on board, but the number of histories of the sort is so insignificant that it is hardly worth recording, and the amount of risk run in such cases was practically nil as compared with those constantly incurred by the Sick Berth Staff in hospital.

Inoculation from Infective Excreta in Double Bottoms and other Parts of the Ship.—The habits of the Maltese labourers working on board have already been referred to at p. 65, and this affords, therefore, quite a reasonable possibility. Information on this point was obtained in 169 cases, of whom nine had, just previous to the onset of illness, been working in bilges, seven in double bottoms, while 153 had not been engaged in any work of the sort.

Inoculation from Infective Urine on the Floor of Ship's Heads or the Dockyard Latrines.—In only one case of the 169 was the person attacked working in heads or latrines, so that the evidence is against this method of transmission. A very similar possibility, however, exists in the practice of going to the ship's head barefoot, especially in view of the prevalence of sea cuts and other aids to inoculation. The very general distribution of cases and the special liability of officers argues against this playing a very important part, but the question was asked in 24 cases, 12 of whom stated that they always wore some form of foot covering, five occasionally went to the head without and seven frequently did so.

Examination of Contacts, Previous Cases, and the Maltese in Ships.—In a ship, as opposed to a house or barrack room, it was obviously waste of time to attempt to examine contacts, and this has accordingly only been done in a few cases occurring ashore. The 13 men composing the hospital guard were examined on the occurrence of a case among them, and the husband and daughter of Mrs. T. (see p. 106), who had been ill some six weeks before she was, were also examined, but in every case the reaction was negative.

The Maltese on Board Ship.—It had been intended to examine for the presence or absence of agglutination reaction all the permanent Maltese in the fleet, and to plate out the urine of those who gave a good reaction. This project was, however, greatly interfered with by the continual absences of the fleet, and in the second place, owing to the constant pressure of other work in the laboratory, one did not feel justified in asking for much work of this sort to be done. Surgeon Hunt of the "Suffolk" very kindly examined the men in his ship, while away on a cruise, and sent those reacting to the laboratory for verification.

The following table represents the results so far as the examination extended:—

Table XXVII.

Ship.	Number of Maltese examined.	Number reacting.	Urine examined.	Number of cases of Mediterranean Fever in year.
"London"	28	1 up to $\frac{1}{50}$ +	—	13
"Implacable"	29	1 " $\frac{1}{20}$ +	—	14
"Diana"	13	1 " $\frac{1}{100}$ +	Once. Nil	4
"Minerva"	18	3 " $\frac{1}{20}$ + 2 " $\frac{1}{10}$ + 1 " $\frac{1}{10}$ ±	Twice. Nil	Nil
"Irresistible"	27	1 " $\frac{1}{10}$ +	—	14
"Suffolk"	20	2 " $\frac{1}{20}$ +	—	Nil this commission
Total	135	12	Nil	

The history of these cases was enquired into in several instances.

The one man in the "London" stated that he had never had any fever, while the one in the "Implacable" was 78 days under treatment in Bighi at the beginning of the year with Mediterranean Fever.

The cases in the "Minerva" were carefully enquired into by Surgeon Richardson, and of the three who gave a good reaction, one stated that he had never been ill; another, that he had only been laid up for about a fortnight three years previously with what was said to be a cold, while the third had had Mediterranean Fever five years before.

The urine was also plated out in three ambulatory cases, two in hospital, and one belonging to the "Diana," and in two previous cases occurring in the "Implacable," and one in the "Carnarvon," but no *Micrococcus melitensis* was ever isolated.

The blood of 48 out of the 53 dockyardsmen who at various times in the early part of the year were embarked in different ships for the purpose of fitting fire control were also examined. Two gave a + reaction in 1 in 10 and 1 in 20 dilution, two only in 1 in 10, and two more gave a doubtful reaction in 1 in 10.

This investigation, so far as it goes, would appear to indicate, that, as might be expected, latent infection exists among the Maltese in ships, but would not suggest that it plays any part in the dissemination of the disease. In the Table above it will be noted that the ships which suffered least had the largest proportion of Maltese giving a positive reaction.

Evidence with regard to the Possibilities of Exposure to Infection Ashore.—Men.—Of the 59 men whose cases were personally investigated, nine were living in Bighi Hospital, and 29 more had recently been there as patients, eight within a month, 11 within two months, and seven within three, the rest over that time. Since the discharge from hospital of these 29, 12 had been ashore in Malta once or twice, seven occasionally, two frequently, while seven had not left the ship. One more had not been ashore in Malta, but occasionally in other places. Similarly, 14 had occasionally (in the majority of instances once or twice) slept ashore since discharge from hospital, and 13 had not done so at all. No information on this point was available about two.

Of the 21 men who had not been resident in hospital, two were once or twice ashore in Malta in the six weeks or more preceding the onset of illness, eight occasionally, three frequently, and two were living ashore, but one of them for only about a week at the range. Three others were occasionally ashore elsewhere, but not at Malta, and three were never ashore at all. The figures with regard to sleeping very closely correspond to the others: seven slept ashore occasionally, three frequently, and 11 had not done so at all.

Officers.—Only one out of the 11 had been previously in hospital, and in the interval between discharge and onset he was living ashore. Of the remainder, one was ashore in Malta once or twice, two occasionally, three frequently, and the remainder, with the exception of one whose destroyer was alongside the dockyard, were living ashore. Only these latter, four in number, had slept ashore at all lately.

Table XXVIII.—Showing Movements of Patients, either for the Entire Interval since Discharge from Hospital or during the 30 Days preceding Onset.

—	Ashore in Malta.				Ashore elsewhere only.		Slept ashore.		
	Once or twice.	Occasionally.	Frequently.	Never.	Occasionally.	Frequently.	Occasionally.	Frequently.	Never.
In hospital.									
Movements known for entire period—									
Within 1 month	8	1	9	3	—	—	4	5	12†
,, 2 months	4	1	4	3*	—	—	3	1	8*
,, 3 ,,	2	—	—	—	—	—	2	—	—
Total	14	2	13	6	—	—	9	6	20
Movements only known for 30 days—									
Within 2 months	3	3	1	1	2	—	5	—	5
,, 3 ,,	4	2	—	2	1	—	4	—	5*
Over that time	1	1	—	—	—	—	2	—	—
Total	8	6	1	3	3	—	11	—	10
Not in hospital.									
Movements only known for 30 days—									
Officers	1	—	2	—	—	1	—	—	4
Men	6	8	9	7*	2	1	12	5	16‡
Grand total	29	16	25	16§	5	2	32	11	50‖

* 1 in dock. † 1 alongside. ‡ 3 in dock. § 2 in dock. ‖ 6 in dock or alongside.

The one officer in hospital previously had been once or twice ashore, but had not slept; his ship was, however, alongside.

The evidence derived from the forms sent in to Staff-Surgeon Shaw relates in the large majority of instances to the movements of patients in the 30 days preceding onset, since that is the form in which the question was put; but in a few, who had recently been in hospital, information is given with regard to the period since discharge. Omitting cases contracted while resident in hospital, and those occurring among the Sick Berth Staff there, and also the Maltese and dockyardsmen, information is available on this point in 93 cases, of whom one officer and 55 men had recently been in hospital, and in 35 of these their movements for the entire interval between discharge and onset are recorded. The results are perhaps best put in tabular form (see Table XXVIII, p. 101).

So far as it goes, therefore, this information—which may be accepted as pretty accurate, since in the large majority of cases it has been verified by examination of leave books—agrees essentially with what has already been stated. Officers, for instance, are seen to go ashore more than the men in the daytime, but, in the case of those serving afloat, to sleep ashore much less frequently. It follows, therefore, that this suggests some cause operating in the daytime to account for the increased liability among them.

It shows also that the majority of the cases developing after treatment in hospital for other illness have been comparatively little exposed to the chance of infection ashore, and that the possibilities of this having occurred during the interval after discharge from hospital are therefore correspondingly lessened.

Facts Pointing to the Contraction of the Disease in Malta rather than elsewhere.—Evidence with regard to the period intervening between departure from Malta and onset of symptoms has been collected in 60 cases which occurred during absence from Malta, and the following table gives the result:—

Table XXIX.—Showing Interval between Departure from Malta and Onset of Symptoms in Cases occurring elsewhere.

Within 1 week.	2 wks.	3 wks.	4 wks.	5 wks.	6 wks.	7 wks.	8 wks.	Over 8 wks.
15	11	11	8	5	4	1	2	3

The enormous majority are seen to occur within a month of departure, and further evidence is afforded by the diminution which inevitably follows the departure of the fleet during the summer, and which during the past two years has been accentuated by the increasing length and frequency of the cruises.

Dockyard. Civilian, English.—A group of cases of Mediterranean Fever occurring among dockyard officials and their families in Sliema.

Incidence of Cases.—The earliest case occurred in the person of Mr. J. J., draughtsman in the dockyard, who lived in a flat situated in one of three houses (House B) belonging to a boarding establishment in Sliema. He had only been in Malta three and a half months and first felt ill on April 12. Almost at the same time, about April 16, two out of four children in the family of another dockyard official, living some 400 yards or more further down the same street (House A), also complained of illness and one gave a positive reaction, the other being only ill for a week and her blood not being tested. On April 27 a third child in the same family became ill, and presented a positive reaction. The fourth and only other child was an infant 10 months old. On going into the history of this second family it was found that until two months previously they had lived in the same house as the first case and, in fact, had for some time been fellow lodgers, but had seen little of one another since leaving. This family had been two and a-half years in Malta and had always used milk unboiled, the children chiefly with porridge. The mother also used the milk, but previously they had none of them suffered from illness. The milk was obtained from the same goat-herd as in the house where the first case occurred. On May 11 Mr. E. H., living in the same boarding establishment as Mr. J. J., but in the third house (House D), that is to say, the house at the opposite end of the establishment of three, had a febrile attack and symptoms suggesting Mediterranean Fever, but gave no reaction. When seen on June 19, however, a tube of blood was obtained and when tested was found to react up to 1 in 200, although he had returned to duty on May 21 and was apparently well. On May 21 Mr. T. C., draughtsman, living in the same house, was attacked by pain in the foot and fever which lasted till the 28th, and on June 8 was placed on the list with what proved to be a severe attack of Mediterranean Fever.

All the houses are situated on the sea front and accordingly in close relation to the very numerous breeding places of Acartomyia which are to be found on the rocks at Sliema, while the street is also much exposed to wind, and consequently to dust. The houses are comparatively recently built and the sanitary arrangements were in all cases modern in design and in good order.

The boarding establishment in which Messrs. J. J., E. H., and T. C. lived consisted, as has been stated, of three houses (B, C, and D), two of which (C and D) were in communication and served as a sort of mess, while the other (B) was let in flats. This latter house had been given up at the time the second case occurred. They were administered and supervised by the same staff, and the milk supply was the same for all. None of the five Maltese servants gave any history of recent illness.

That part of the establishment used as a mess accommodated nine dockyard officers, four of whom lived in the middle house (House C) (none of whom were attacked), while five lived in the end house (D) and two of them suffered. Among them, Mr. T. C. had been the shortest time in Malta (nine months), while Mr. E. H. had been two years in the island. All except one had been in the habit of taking fresh goats' milk with porridge and also in tea; the one exception took it in tea only. He has not suffered from Mediterranean Fever. Mr. J. J., the first case, who had lived in the other house (B) in a flat with his wife, also took it with porridge.

All but two of the nine used mosquito nets, and all agreed in saying that mosquitoes had not been troublesome this year, but that last year they were a great nuisance in the dockyard. The two who used no curtains were neither of them attacked; one of them lived in the centre house of the three (C) where no case occurred, and the other in the same house (D) as the last two patients. Mr. J. J. also used a mosquito curtain and stated that he was extremely particular about it, examining it each night with a candle before retiring. Mr. T. C. appears to have been in the habit of doing much the same.

Previous Cases in House.—Two cases had occurred in August and September, 1905, both of whom lived in house (D). In addition, another of the mess had been attacked after arrival in England on leave about August, 1904, but at this time, although the establishment was the same, the house was an entirely different one and in a street further from the sea.

Milk Supply.—The same goat-herd had supplied the establishment for a long time and was in addition the usual source of supply for the family in which the three children were attacked, but in contra-distinction to the latter who drank the milk unsterilised the proprietress assured me that the milk was always scalded before use and was most emphatic in her expressions of confidence in the reliability of her Maltese servants on some doubt as to this being suggested. On the occurrence of the second case (Mr. T. C.), however, the house was again visited, and some milk standing by his bedside was tested and found to give the characteristic reaction with the ortol test. A further sample was then requested and was brought up by one of the servants who, on seeing the test about to be applied, volunteered the information that it had not yet been scalded. As the hour at which the milk was delivered was said to be 5.30 a.m., and it was then nearly noon, one may be pardoned for expressing doubts as to whether the confidence reposed in her domestics by the mistress of the house was not misplaced. A sample of this milk was sent to the laboratory, but was too contaminated for examination.

Samples were afterwards obtained from 20 of the animals belonging to this goat-herd and one was found on repeated examination to give a

very marked reaction and was frequently plated out in the Public Health Department, but *Micrococcus melitensis* was never isolated. This herd is dealt with in Dr. Critien's report, and on comparison with him it was found that he received notifications of three cases from a house (House E) in a street quite a quarter of a mile away, but supplied by the same milkman. The dates of onset in these three were April 20 and 24 and June 15 respectively.

Among the persons, therefore, supplied by this herd, which included at least one infected animal, no less than eight undoubted and one possible case of Mediterranean Fever occurred within a comparatively short space of time. These were located in four different houses, in three instances widely separated from one another, while no such correspondence was to be found between them in conditions suggesting other methods of infection.

The following table recapitulates the dates of onset:—

Table XXX.

Name.	Sex.	Date of onset.	House.	Remarks.
Mr. J. J.	M.	April 12	B	
C. J.	M.	„ 16	A	
C. J.	F.	„ 16	A	Only a week ill. No examination for reaction
Mr. S.	M.	„ 20	E	Dr. Critien's report
Mr. G.	M.	„ 24	E	„ „
F. J.	F.	„ 27	A	
Mr. E. H.	M.	May 11	D	Only a week ill, but reacted in dilutions up to 1 in 200
Mr. T. C.	M.	„ 21	D	
Mr. O'R.	M.	June 15	E	Dr. Critien's report

It may be mentioned that Messrs. J. J., E. H., and T. C. all worked in the dockyard, in the same block of buildings, and stated that last year they were much troubled there by the attacks of what was evidently from the description *Stegomyia fasciata*. All, however, agreed in stating that up to the time of illness this year none had been seen, which is quite in accordance with what might be anticipated at the time of year. At all events, the prevalence of mosquitoes in the dockyard would throw no light on the remaining cases and the probabilities would seem to be enormously in favour of milk as the vehicle of infection in this series of patients.

Isolated Cases among English Civilian Dockyard Employees.—In addition to the group of cases just discussed, three isolated cases were personally investigated.

Environmental Conditions.—One man, S. B., an engine fitter, lived in Vittoriosa; a second, E. W., and the third case, a female, Mrs. T.,

the wife of a dockyard employee, lived in different parts of Senglea. In all three cases the house was situated in dirty crowded localities, infested by goats and other animals, and in all three the sanitary arrangements were of the peculiar Maltese type described by Johnstone, and left much to be desired. By far the most objectionable in this respect was that of Mrs. T., where there was a hand-flushed closet pan in the small room where cooking was carried on, an open communication with the drain just outside the window, and another hand-flushed closet just outside her bedroom door. With regard to the sanitary condition of surroundings, therefore, these few cases are seen to afford a most notable contrast to the conditions under which most cases in the Service afloat are contracted.

Milk History.—S. B. had been in hospital in January, 1906, for some considerable time with rheumatic symptoms and a slight urethral discharge. On February 2nd, but never again, his blood had given a positive reaction in a dilution of 1 in 50. During this stay he had had milk, and he had also been in the habit of drinking it by itself in his own home; but in his present lodgings, which he had occupied since discharge from hospital, it was said to be tinned. The symptoms of his definite attack of Mediterranean Fever began early in June, but the probabilities are rather in favour of his first stay being also due to this cause.

In both the other cases a milk history was easily established, E. W. taking it in egg flips and Mrs. T. with fruit. In both cases the milk was obtained in the usual way from casual goat-herds at the door.

Contact.—In the case of the two men there had been no recent illness of any sort in the house, but the husband and one daughter of Mrs. T., both of whom had taken milk, had, some six weeks previously, suffered from pyrexia. In both, however, the agglutination reaction was negative.

Mosquitoes.—S. B. stated that these had troubled him in the house he had occupied before going to hospital the first time, but not in this one. E. W., whose symptoms were first noticed about the middle of September, had been much attacked in the boiler shop in the dockyard by a striped mosquito, evidently Stegomyia, and by a smaller variety in his house, but Mrs. T. had not noticed any. Neither of these three persons used nets, and the probabilities are that mosquitoes were numerous in all three houses.

Maltese.—The Maltese personally interviewed included four serving in ships, and one policeman in the dockyard. All, however, slept ashore while at Malta. Owing to linguistic and other difficulties, information had been hard to obtain in these cases and is not altogether reliable, more particularly with regard to previous history, contact with other cases, and facts relating to mosquitoes.

The details may be summarised as follows :—

All lived in entirely different parts of Malta, including Cospicua, Casal Paula, Zabbar, Misida, and Senglea, and all belonged to different ships. Three gave histories of similar illness previously, two nine years before, and the third in 1905, but neither had been in hospital. Four occurred while at Malta, the last a fortnight after leaving.

Contact and Mosquitoes.—No history of any contact with pre-existing cases could be obtained. One man said he was never troubled by mosquitoes, a second was occasionally bitten, a third that they were numerous in his house, but that he used a sheet as a protection. No information could be obtained from the other two on this point.

Milk History.—Two drank milk freely by itself, a third took it with porridge and fruit, and occasionally by itself on board his ship (he was a gunroom domestic), the fourth took it only in tea except when ill, and the remaining man denied taking it at all, but his knowledge of English was so limited that the information in this case is by no means reliable. Four cases were reported on the old forms, and of these two drank milk; about one man it is stated that he did not drink it on board, and as to the fourth there is no information whatever on this point.

The evidence to be derived from these few odd dockyard cases and Maltese is entirely inconclusive, but on the whole it is not incompatible with milk infection.

III. A MORE COMPLETE HISTORY OF THE OUTBREAK OF MEDITERRANEAN FEVER ON BOARD THE S.S. "JOSHUA NICHOLSON."

The original account of this outbreak of Mediterranean Fever on board the "Joshua Nicholson" was given in the correspondence column of the 'Journal of the Royal Army Medical Corps' for January, 1906, in the following letters from Dr. M. Armand Ruffer, Captain Kennedy, R.A.M.C., Malta, and Dr. Gotschlich, Director of Sanitary Services at Alexandria, respectively, and in an editorial in February, 1906:—

Dear Bruce,—I have just seen Dr. Gotschlich, who told me of a ship starting from Malta with a number of milch goats for London. The captain, officers, and a certain number of the crew drank the milk, and nearly all those that did so contracted Malta Fever, whereas the others did not. I have urged Dr. Gotschlich to publish particulars at once.

Yours sincerely,

M. Armand Ruffer.

Dear Colonel Bruce,—I came across a very interesting thing in connection with the infection of Mediterranean Fever by means of goats' milk. I got to hear from Dr. Stilon, who is writing for fuller

particulars, of a ship trading between Antwerp and Egypt, which called in here the other evening, and the captain of which and another man came ashore to consult Dr. Stilon, who found them suffering from symptoms of Mediterranean Fever. He took samples of their blood, which he sent to the laboratory. Dr. Micallef did the reactions, and I only saw them after he had put them up, when there was an undoubted reaction. He had no more blood for me to test.

These two men left Malta on board their ship early next morning, and I did not hear of the case for 24 hours after, but particulars of which, as far as I can gather from Dr. Stilon, are as follows:—

Two months ago the s.s. "Joshua Nicholson" called at Malta and shipped some goats for Antwerp. On the way the crew drank the goats' milk unboiled, with the exception of one man (a carpenter or engineer), who refused it. At Antwerp they left the goats and shipped on a new crew, with the exception of the captain, the mate, the above-mentioned carpenter or engineer, and two other men. After leaving Antwerp, one of these five men went sick, and had to be landed at Gibraltar; another was very ill at Alexandria, and his blood was sent ashore to be tested, and was said to react to *Micrococcus melitensis.* They proceeded to Odessa, where others fell sick, and by the time they had come back to Malta all of the five men were sick with the exception of the one man who refused to drink the goats' milk.

I have written to Horrocks, at Gibraltar, asking him to try to trace the man who landed there, and Dr. Stilon is writing to Antwerp to get more particulars, which I have asked him for. It is most unlikely that the infection was contracted in any other way, as they merely stayed here a few hours, and did not, I suppose, even land.

Yours sincerely,
(Signed) J. CRAWFORD KENNEDY.

Valletta, Malta,
December 14, 1905.

The Editor, 'ROYAL ARMY MEDICAL CORPS JOURNAL.'

DEAR SIR,—At your request I send a report of a small epidemic of Malta Fever, which occurred on board the s.s. "Joshua Nicholson" (Ellerman Line). On October 21 last, Frederick Jenkins, aged 33, steward of the s.s. "Joshua Nicholson," which was anchored in our port, was admitted into the Deaconesses' Hospital of our city with the clinical signs of Malta Fever. At the request of Dr. Morrison, physician of the said hospital, I made a bacteriological examination of the blood of this patient (Widal's reaction), with the following result:—Positive agglutination with the *Micrococcus melitensis* in a dilution of 1 in 1200; control with the *Bacillus typhosus abdominalis*, negative in a dilution of 1 in 50. The result of the bacteriological

examination thus corroborates the diagnosis of Malta Fever. The patient left hospital, cured, on the 4th instant.

Dr. Morrison had the kindness to draw my attention to the history of the case, which is very interesting from the point of view of the relation between the infection by the *Micrococcus melitensis* in man and in the goat. Based on these communications on the part of Dr. Morrison, and on the information which I have been able to collect from the patient himself, the history of infection in this case is as follows:—

The s.s. "Joshua Nicholson" had, on the occasion of its previous voyage, starting from Odessa, anchored about August 19 last for about one day in the port of Malta to take on board a flock of 65 goats, destined for the United States of North America. Seeing that the stay of the ship at Malta had only been of so short duration, and seeing that, as I am assured, no one left the ship to go on shore, it is extremely improbable that the cases of Mediterranean Fever, which appeared later amongst the crew of this vessel, could have been contracted during the stay at Malta by direct or indirect contagion. The ship then continued her course from Malta to Antwerp, where she arrived about September 5 last. During the whole voyage every one on board (to the total of 24) had drunk fresh milk from the goats embarked at Malta. These latter were transhipped two or three days after arrival at Antwerp to a ship leaving for a port in North America, of which, unfortunately, I have not been able to learn either the name or the exact locality.

The s.s. "Joshua Nicholson" remained at Antwerp for about two weeks, proceeding next to London. It was during the last days of the stay at Antwerp, or during the voyage to London (I have not been able to obtain exact information on the subject of these dates), that four people on board fell sick with fever, whilst during the whole of the voyage from Malta to Antwerp, and during the greater part of the stay in the latter port, every one had been in perfect health. The sick were: the captain (slightly attacked), the first officer, the chief engineer, and the steward. As to the last, I have been able to prove, since his arrival here, that he suffered from a typical attack of Malta Fever; as to the three others, it has been impossible for me to obtain a bacteriological examination of their blood, but I have been assured that their clinical symptoms were absolutely identical with those observed in the steward. In all probability Malta Fever was present in all four cases. In addition, there is a fifth case, a certain Swartier (?), treated in the Dreadnought Hospital at Greenwich, London, but I have not been able to learn what may have been the symptoms of his sickness. Perhaps it would be possible to obtain information with regard to him from the authorities of the above hospital. It would, indeed, be particularly interesting to know if

this individual also had Mediterranean Fever, for that would prove that the case existed, not exclusively in the officers' quarters (captain, first officer, and where the steward principally carried out his duties), but also among the crew.

To sum up, we find ourselves in the presence of a small epidemic of Mediterranean Fever on board a ship which had embarked a flock of goats at Malta, and among persons who had drunk unboiled milk from these goats. Now, as according to the researches of the Commission of the Royal Society for the investigation of Malta Fever, the goats of Malta are very frequently infected by this malady, and as it is proved directly that the *Micrococcus melitensis* is secreted often in enormous quantities in the milk of these goats, there would be nothing surprising in finding that people who had drunk such milk had contracted this infection; besides, this will be the first time that this mode of infection in man by the milk of the goat will be directly demonstrated. The hypothesis would have more in support if one could prove that the above-mentioned Swartier, one of the crew, had likewise been attacked by Malta Fever. But if that is not the case, we ought not to disguise from ourselves that there may be yet another possible way of explaining the infection in this little epidemic—it is, that all the four people attacked were in the officers' quarters, and were there daily in contact with a passenger, an American, who had been several months in Malta buying the flocks of goats, and who accompanied the latter to their destination. Unfortunately, I have not been able to get the name of this gentleman. As to his state of health, the steward assured me that he was apparently always very well—nevertheless, this does not exclude the possibility that this gentleman may have contracted Mediterranean Fever during his long stay in Malta, and that he may have retained and propagated the infection in the latent stage, *e.g.*, by the urine, following the analogy of certain convalescents from typhoid fever who, while being apparently in perfect health, can for several months propagate the infection. Perhaps it may be possible to clear up this question by later investigations on the subject of this passenger.

As regards the goats, which, according to what I have heard were destined for establishments for supplying milk to children in America, I have drawn the attention of the Consul of the United States in our city to the danger likely to ensue under this head.

Up to the present I have not been able to get further information as to what has become of these goats.

Pray accept, Mr. Editor, the assurance of my esteem.

(Signed) E. Gotschlich,

Director of Municipal Sanitary Services of Alexandria.

Alexandria,

December 8, 1905.

More recent investigation has elicited additional facts in connection with the causation of this outbreak, and has also shown that some of the details as originally stated were not quite in accordance with the actual circumstances. I propose, therefore, to recapitulate the facts from the beginning.

Much of the additional information has been obtained directly from the chief of the three goat-herds who accompanied the animals to America, and from the captain, chief engineer, and steward of the "Joshua Nicholson," who still belong to the ship.

The History of the Goats.—The entire herd numbered 65, of which 61 were milch goats. These had been gradually collected in Malta by Mr. Thompson, of the Bureau of Animal Industry, U.S.A., who had been living in the Island for some months for the purpose.

These goats were embarked for Antwerp, en route to America, in the s.s. "Joshua Nicholson," which called at Malta on August 19, 1905, for a few hours. Mr. Thompson and three Maltese goat-herds accompanied them. The animals were placed in pens on deck in the waist, over the after hold, where they must have been somewhat crowded together from the restricted space available. One milch goat, a prize animal—and the finest of the herd—died the day after sailing, and was examined *post-mortem* by Mr. Thompson, who decided that pneumonia was the cause of death.

Except on one occasion the weather during the voyage is said to have been good, but as the two assistant goat-herds were seasick most of the trip, the goats may possibly have also suffered. At all events, there is a discrepancy between the accounts of the chief goat-herd and the people in the ship: the former declaring that all the animals were in good health and milking during the entire journey to America, and that the total output was about 120 quarts (30 gallons), but the latter insist that the supply of milk greatly diminished towards the end of the voyage to Antwerp and that the chief goat-herd was much concerned and spoke to Mr. Thompson on the subject. This information I obtained independently from two persons who entirely agreed in their evidence and am therefore inclined to believe that the goat-herd's memory fails him in this respect; more particularly as on again questioning him with reference to this point he admitted that three or four goats did fail to secrete milk when the ship was nearing Antwerp.

Most of the ship's company drank freely of the milk during the trip. For those living aft it was collected in a large salad bowl or soup tureen which held the milk of three or four goats, but from the steward's account, the majority of the men used their own pannikins and in consequence often drank the undiluted milk of a single animal.

The ship arrived at Antwerp on September 2, and the goats were at once landed and sent to the quarantine station. Here they remained

five days, during which time, by Mr. Thompson's order, the goat-herd gave milk from the goats to several persons in and around the station.

On September 7 the herd was embarked in the s.s. "St. Andrew" for passage to New York, Mr. Thompson and the three goat-herds once more accompanying them. The goats were accommodated in this vessel down below in the hold, and not on deck. The weather according to the goat-herd was bad throughout the trip: he further states that the 61 goats were still all milking, but as one of them was dead, a fact he had evidently forgotten, his evidence cannot be accepted as entirely trustworthy on this particular point. The captain of the "St. Andrew," however, corroborates him to some extent, and says that the total output of milk was about 160 quarts (40 gallons).

With regard to the collection of milk, one utensil appears to have been used for the officers and one for the crew, but some of the latter at times drank the undiluted milk of a single goat. Most of the ship's company seem to have drunk the milk.

The ship arrived at New York about September 21 to 23, and the animals were at once taken to the quarantine station in Athenia, N.J., and have been kept in quarantine ever since. Very shortly after their arrival, in the early part of October, the urine, blood, and milk of 60 (the remaining five having died) were examined. The blood of 14 showed a well marked agglutination reaction with *Micrococcus melitensis*, 18 more showed an imperfect reaction and 28 gave none. A Micrococcus corresponding in morphology and cultural characteristics to the *Micrococcus melitensis* was isolated from the milk of two of the goats on November 27 and subsequently from that of several more. All the goats have been kept constantly in quarantine and the infected ones have been killed off from time to time. At present 35 of the original goats and 40 kids of various ages remain in quarantine at the Government Experiment Station at Bethesda, Md.

The Incidence of Mediterranean Fever Among those who Partook of the Milk.

In the s.s. "Joshua Nicholson."—In this ship there were 23 officers and men during the voyage from Malta to Antwerp. Eleven of them left the ship at the same time as the goats and the after history of eight of these is unknown, but the remaining three are said by the captain to have been later under treatment in hospital at Antwerp with very similar symptoms to those from which he and the other men suffered. Their names and ratings are :—J. Johansen, carpenter; E. Olsen, boatswain; and De Halle, mess-room steward. The only one of these men, however, about whom any information is to be obtained in Antwerp is Olsen, who was in hospital there, but the only medical history is one of hernia.

Twelve of the original crew were left on board and the following

table gives (1) the names and ratings, (2) whether or not they suffered from illness, (3) whether such illness was verified by the agglutination reaction, and (4) the date of such verification. A more detailed account of the after history of each person is given subsequently.

Table.—Cases of Malta Fever in the Crew of the "Joshua Nicholson."

Name.	Rank or rating.	Whether sick or not.	Whether verified by agglutination.	Place and date.
A. Cherry ...	Master	Yes	Yes	Malta 4/12/05
F. Simonds	1st mate	,,	,,	,, 4/12/05
D. Smart ...	Ch. eng.	,,	Reacted July/06	,, 25/7/06
Unknown ...	2nd mate	No	No	
F. Jenkins	Steward	Yes	Yes	Alexandria 21/10/05
A. Visschers	Cook	Yes (still sick)	Not known	
P. Swaters	A.B.	Yes	Yes	Greenwich December/05
Johansen ...	A.B.	Yes (ambulatory)	No	
E. Martin...	Donkeyman	Yes	,,	
Spurgeon ...	Engineer	No	,,	
Mieback ...	,,	,,	,,	
Jenkins ...	Cabin boy	,,	,,	

The next table gives the movements of the ship during the voyage under consideration and for the following few months, which will help to make clear the history of these cases.

Table.—Movements of the "Joshua Nicholson."

From—	Date of departure.	To—	Date of arrival.
Malta	August 19/05	Antwerp	September 2/05
Antwerp	September 20/05	London	,, 22/05
London	October 1/05	Gibraltar	October 9/05
Gibraltar	,, 9/05	Malta	,, 15/05
Malta	,, 18/05	Alexandria	,, 21/05
Alexandria	,, 27/05	Odessa	November 3/05
Odessa	November 28/05	Constantinople ...	,, 30/05
Constantinople ...	,, 30/05	Malta	December 4/05
Malta	December 4/05	Antwerp	,, 17/05
Antwerp	January 1/06	London	January 2/06
London	,, 8/06	Gibraltar	,, 15/06
Gibraltar	,, 16/06	Malta	,, 21/06

Of the 12 persons left in the ship four did not develop any symptoms of illness, and will, therefore, be dealt with first. They were the second mate, the cabin boy and the two engineers.

The second mate began drinking the milk, but found that it produced constipation and otherwise disagreed with him, and he therefore ceased taking it after having had but very little. He left the ship in

London some time between September 22 and October 1, apparently perfectly well, and cannot now be traced.

The cabin boy on this trip was the brother of the steward (who is now again in the ship) and has therefore been under observation up to the present time. The steward states that the milk disagreed with the cabin boy also, that he drank hardly any, and that he has had no illness.

The two engineers remained in the ship for the next voyage, but never had any sickness. They both drank milk, but told the steward that they always boiled it, to which he replied that he did not do so, as neither Mr. Thompson nor the captain thought it necessary.

The remaining eight persons all developed illness with very similar symptoms and five at least have given a positive agglutination reaction with *Micrococcus melitensis*, in dilution sufficiently high to eliminate the possibility of the reaction being due to other than specific agglutinins. In no case could a history of a previous attack of Malta Fever be obtained.

To take these eight persons seriatim:—

(1) *The captain*, who drank a great deal of the milk, states that he, together with the remaining seven (although the chief engineer and steward do not acquiesce in this latter assertion), first began to ail about August 31 or September 1, just a day or two before arrival at Antwerp. He was not, however, sufficiently ill to prevent him from doing duty or to necessitate his consulting a doctor until arrival in Constantinople on November 30, although he was noticed by the chief engineer and steward to be seedy while at Antwerp, and, moreover, was treating himself together with a number of the crew while on passage from London to Gibraltar and Malta. On November 30 he was so ill that he had to consult a doctor ashore at Constantinople, and on December 4 he came under the care of Dr. Stilon at Malta who had his blood and that of the first mate examined in the Public Health Laboratory, where they were both found to react to *Micrococcus melitensis*. The captain apparently improved somewhat after this, but on the next voyage out, about January 14, was exceedingly ill, and was seen by a doctor ashore at Gibraltar and again by Dr. Stilon at Malta on arrival there on January 21. On returning to England from this voyage he was under the care of Sir A. E. Wright and is now well, although his blood serum (July, 1906) still reacts in all dilutions up to 1 in 500.

(2) *The first mate*, like the captain, also drank the milk freely. He appears to have been able to carry on his work, and did not see a doctor until arrival at Malta on December 4, as already described. Subsequently, on the voyage from Malta to Antwerp, he began to have "rheumatic" pains, and, after sustaining an injury, some of his joints became swollen. On arrival in London on January 2, he left

the ship still unwell, and was under treatment by his own doctor at East Ham.

(3) *The chief engineer* usually drank the milk diluted with water. He was feeling quite well, he says, on arrival in Antwerp, and continued in good health until he got wet through the day before sailing for London, that is, September 19. This resulted in what he describes as a succession of colds which he could not shake off and for which he was under treatment by his own doctor at Forest Gate from September 22 to October 1, when he rejoined the ship. After leaving London he began to have various pains about the body and had an attack of fever, temperature 102° or 103° F., for which he was treated by the captain. He had pretty well recovered by the time the ship was between Malta and Alexandria (about October 20), and has had no return of illness, but his blood on July 25, 1906, reacted up to 1 in 80.

(4) *The steward*, who says he drank a very great deal of the milk, gives the same date for the commencement of his illness as the chief engineer, as he independently stated that he was wet through the day before leaving Antwerp (September 19) and had as a result severe shivering fits and could not get warm. This was followed by profuse sweats. He says that he was feeling particularly well on arrival in Antwerp, and, in fact, commented on it in writing to his wife. He managed to carry on his work until arrival at Alexandria on October 21, when he was so ill that he had to be sent ashore to the Deaconess Hospital. Here his illness was diagnosed as Mediterranean Fever and the diagnosis verified by the agglutination reaction (1 in 200). He was in hospital till December and then went home by mail steamer and rejoined his ship in London. His blood still reacted in dilutions up to 1 in 50 in July, 1906.

(5) *The cook* also drank the milk and was feeling ill during the voyage from London, but was able to continue his work until arrival at Antwerp again on December 17, when, being crippled by "rheumatism," he was obliged to leave the ship. He attended as an out-patient at a hospital there for some time, but got little benefit, and when the ship was at Antwerp about May or June, 1906, came on board for two or three weeks to try to do duty, but was obliged to give up. As far as is known his blood has not been tested.

(6) *Swaters, A. B.*—The history of this case is given in an editorial in the 'Journal of the Royal Army Medical Corps' for February, 1906. He appears to have drunk the milk like the others, and gives the date of onset of his illness as September 22, when symptoms came on suddenly. He was sent to the Dreadnought Hospital on September 29. Here a diagnosis was at first made of enteric as he gave a positive Widal reaction, but in December he reacted to *Micrococcus melitensis*, and had a typical attack of Mediterranean Fever.

(7) *Johansen, A. B.*—This man also drank the milk. He remained in the ship for the voyage to Malta, Alexandria, and Odessa, but was complaining of illness all the time, and left the ship at Antwerp on arrival in December. As far as is known, there is no record of blood examination.

(8) *Martin, Donkeyman.*—This man also drank the milk, but, as far as is known, his blood was not examined, and he has left the ship and cannot be traced. This was a mild case, and in date of onset, nature of symptoms, and duration practically corresponded to that of the chief engineer who appears, when in London, to have given him some of his own medicine.

Mr. Thompson, the passenger, is dealt with under heading "In America" (see below), and details relating to the three Maltese goat-herds are given on p. 117.

I am informed that for the five days at Antwerp the goats were in quarantine the milk was consumed both raw and boiled by the *personnel* of the station, and by many people in the neighbourhood with, so far as can be ascertained, no ill effect in any case. These persons, it is said, were enthusiastic about the quality of the milk.

The goats were visited on arrival and departure by the sanitary authorities, and were said to be perfectly well.

In the s.s. "St. Andrew."—The crew of the "St. Andrew" numbered about 30, most of whom took the milk, and there were on board in addition 30 cattle-men returning to the United States who also drank it, but up to the present it has been impossible to trace these men. It is obvious, therefore, that there were a great many more people *drinking* the milk than in the "Joshua Nicholson"—some 60 individuals instead of 23. Both the owners and the master of this ship, the latter of whom says that he has had the majority of the ship's company under observation up to the date of his letter (June 11, 1906), concur in stating that none of the men have suffered from any illness.

In America.—The Chief of the Bureau of Animal Industry states that since the arrival of the goats in America, although a number of persons have drunk each as much as a glassful of milk, only two persons can be said to have ingested it in any quantity.

One, *the Mr. Thompson* who purchased the goats and had been taking the milk for some time, died rather suddenly in January, 1906, of what was diagnosed bilateral pneumonia following influenza. No *post-mortem* was made, and no blood was obtainable for making an agglutination test with *Micrococcus melitensis*.

With regard to Mr. Thompson, the captain of the "Joshua Nicholson" considers that he was "sickening for something" at about the same time as himself and with very similar symptoms, namely, slackness and anorexia. Mr. Thompson himself said it was "liver."

The steward states that he did not notice anything definitely wrong with him, but that his appetite was poor during the entire voyage. From his physician's report, however, it would appear that on arrival in America he was perfectly well.

The other person, an unnamed *female* living in Athenia, N.J., who had been drinking mixed milk from several goats daily for a considerable but not very definitely known period, became sick in December, 1905, with Mediterranean Fever, diagnosed by the clinical symptoms, and the fact that her blood serum yielded a positive agglutination reaction with *Micrococcus melitensis.*

Epidemiological Observations.

In the "Joshua Nicholson."—The ship is the usual type of cargo steamer built in 1880, of 1853 tons gross (1196 tons net), 270 feet in length by 35 feet in breadth, with a raised poop and forecastle containing living spaces for officers and crew respectively, and in the waist two hold spaces separated by the engine and boiler rooms. Amidships there are deckhouses for the accommodation of part of the officers and crew.

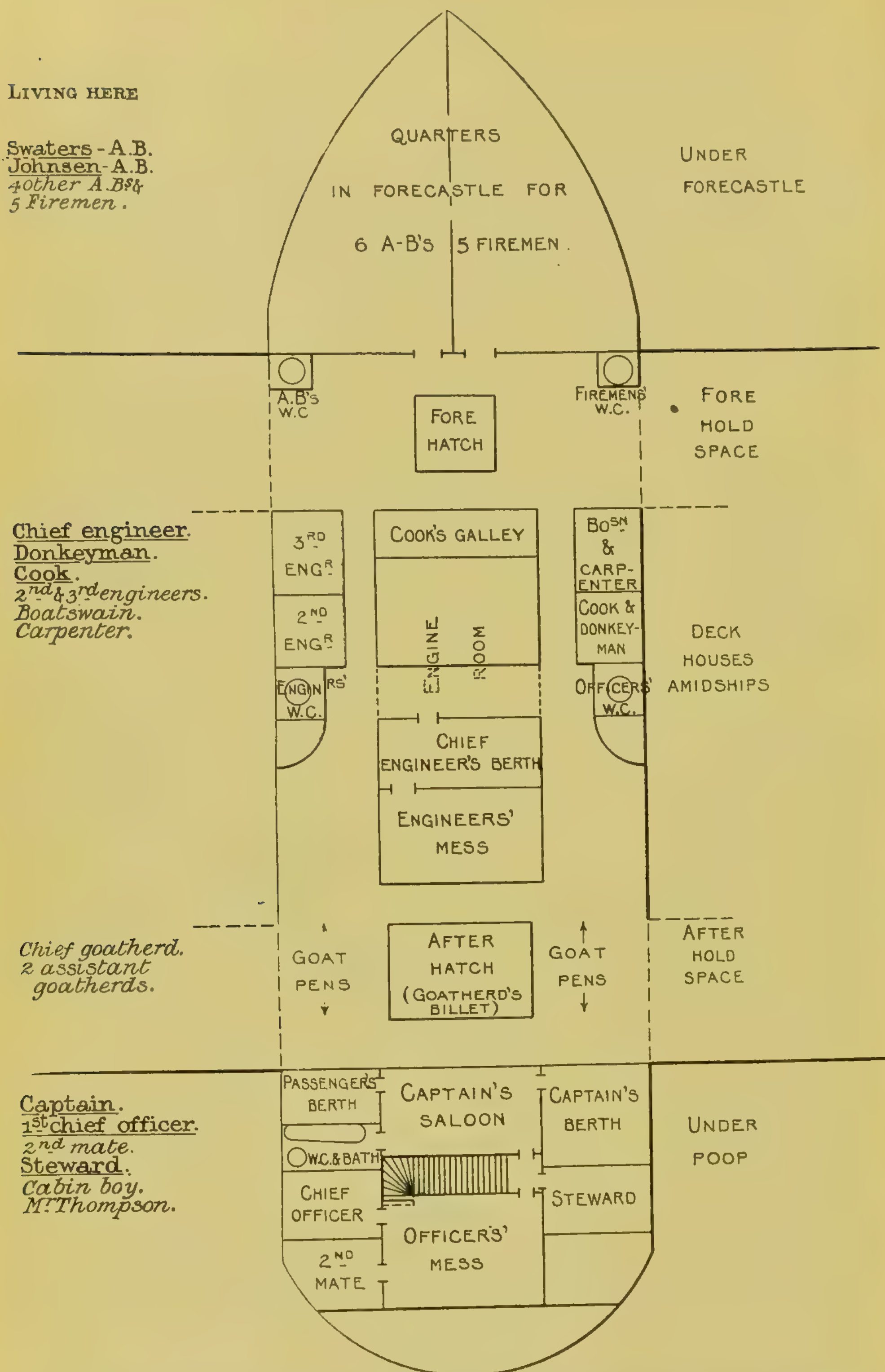
There are, therefore, three separate portions of the ship utilised as living spaces, and it will be instructive in connection with the possibility of contact infection to consider in more detail the persons inhabiting these various portions, and the incidence of illness among them. It will, however, be as well to indicate first the possible sources of infection and their position during the trip.

The Possibility of Contact Infection.—Mr. Thompson had spent some months in Malta, and may possibly have contracted the disease there and been suffering from its effects during the voyage; he lived aft under the poop, in a sleeping cabin on the port side of the captain's cabin, the latter's own sleeping cabin being on the starboard side.

The three goat-herds were natives of Malta, most probably had already had an attack of Malta Fever, and may quite conceivably have been excreting *Micrococcus melitensis* in the urine, or, judging from Shaw's work on the ambulatory type of the disease, had the organism circulating in their blood. It has only been possible to obtain the chief goat-herd's blood for examination (the other two goat-herds being still in America), but this gave a very marked reaction in a dilution of 1 in 20. A specimen of his urine was also obtained and plated, but no *Micrococcus melitensis* could be detected.

All three goat-herds messed and slept on the after hatch close alongside the goats.

Lastly, there were the goats, which, as has already been stated, lived in pens placed in the waist, abaft the engine-room and over the after holds. How many of these animals were passing *Micrococcus melitensis*



Sketch-plan of s.s. "Joshua Nicholson," showing positions where the various persons in the ship, during the voyage from Malta to Antwerp, messed and slept. Names underlined are known to have subsequently developed illness, and in five at least out of the number this was verified as Mediterranean Fever by the agglutination reaction.

either in urine or milk or in both during the voyage it is impossible to say.

Localisation of Cases.—Under the poop in the aftermost part of the ship there was, abaft the captain's cabin, where he and Mr. Thompson lived, the officers' mess, inhabited by the first and second mates. The steward and his brother, the cabin boy, also had their meals and slept in a cabin down here.

Of those living in this part of the ship, therefore, the captain, first mate and steward contracted the fever, verified in all three cases by the agglutination reaction; while the second mate, cabin boy and, presumably, Mr. Thompson escaped.

Amidships was the chief engineer's cabin, and the engineers' mess; on one side were the quarters of the donkey-man and the cook, while on the other side and a little further forward the two engineers, the carpenter and boatswain were berthed.

Of the people living in this portion of the ship, therefore, who still remained in her after leaving Antwerp, the chief engineer, donkeyman, and cook, were all ill, and the two engineers escaped. Only in one of these cases has the diagnosis been verified by the agglutination reaction, viz., that of the chief engineer, whose blood still reacted 1 in 80 when examined in July, 1906.

Forward under the forecastle were the quarters for five firemen and six seamen. Of these, two seamen, Swaters and Johansen, are known to have been ill; in the former case the diagnosis of Malta Fever being verified by the agglutination reaction; the remainder of the men left the ship at the same time as the goats, and have since been lost sight of.

Infection from Urine.—Although no *Micrococcus melitensis* was recovered from the chief goat-herd's urine in the one examination made, this by no means negatives the possibility that he was passing the organism in his urine in August, 1905. Of the persons, however, who might have been excreting infective urine, one, Mr. Thompson, would use the officers' latrine, while the goat-herds would make use of the men's. Similarly, the distribution of illness among those attacked would not incriminate any one latrine. As regards the risk of infection from the goats' urine, one would expect the barefooted seamen who also scrubbed the deck to be more liable to inoculation than the booted officers. Convection by flies is of course a possibility, but as the ship sailed at once, it is decidedly unlikely that flies or other insects remained long on the upper deck where the goats were located.

Infection from Biting Flies.—Though possible, the distribution of the cases in all parts of the ship, and the fact that she was only a few hours in Malta, moored in the stream, and put to sea at once, renders this distinctly improbable.

Infection from Ingestion of Milk.—This is the one common factor, and its probability is immensely strengthened by the two facts that all who are known to have taken little milk, or to have boiled the milk before drinking it, escaped, and that one of the only two persons who drank it to any extent in America, far from the endemic area and almost removed from the possibility of contact infection, contracted a typical attack.

At Antwerp.—It is difficult to understand why the persons who drank the milk at Antwerp escaped infection. It must, however, be remembered that it was taken at the most for a period of five days, and that two separate informants in the "Joshua Nicholson" say that the goats had largely ceased to secrete milk at the end of the trip from Malta. As the Micrococcus could only be isolated from the milk of two when first examined in America (in November, two months after arrival), it does not seem improbable that those passing the cocci should either have ceased to do so at this time, or that the number excreted should have very greatly diminished. Moreover, it is not altogether unreasonable to suppose that these animals, infected by the Micrococcus and not therefore in a normal condition of health, would be among the first to respond to any conditions adversely affecting the secretion of milk.

In the "St. Andrew."—This is far more difficult to explain, but certain facts must be taken into consideration. In the first place, the voyage was one across the Atlantic, and more stormy weather was met with than in the "Joshua Nicholson." In the second, the ship was no longer in the subtropics, but in wintry northern seas, and, finally, the goats were below in a stuffy hold and not on the upper deck.

The possibility that the secretion of the milk was interfered with is, therefore, considerably greater than in the "Joshua Nicholson." Again, the number of persons amongst whom the milk was distributed was almost three times as large as that comprising the crew of the "Joshua Nicholson," consequently the amount of milk available per head, even supposing the goats were yielding as well, would be much diminished.

In America.—In this case there was no possibility of previous exposure, and infection by contact is far less probable than in the ship. Mr. Thompson went to Washington the day after arrival, so that he, as a possible source of infection, can be disregarded. The goat-herds and the goats themselves were at the quarantine station, but the patient could not have been exposed to the same chances of contact infection as those in the ship. On the other hand, there is the positive evidence that she had drunk a considerable amount of milk from various goats of the herd, and that this probably insluded infected milk.

Duration of Period between Ingestion of Goats' Milk (some of which was

undoubtedly infective) and the Development of Symptoms.—Assuming milk to be the vehicle of infection, the following table gives the interval in days which intervened between the time during which the milk was being consumed and the first development of symptoms in the three cases in which this latter point is definitely known.

Table.

Name.	Dates of ingestion of milk.	Date of onset.	Interval.
D. Smart	Between Aug. 19 and Sept. 1	Sept. 19	31 to 18 days
F. Jenkins......	„ „	„ 19	31 „ 18 „
Swaters	„ „	„ 22	34 „ 21 „

In conclusion, I have to acknowledge the kindness of Mr. Grout, of the American Consular Service in Valletta, who not only first enabled me to see the chief goat-herd and trace the goats, but also gave me much assistance otherwise. I am also indebted for much information to Dr. A. D. Melvin, Director of the Bureau of Animal Industry, U.S.A.; to Messrs. O. F. Gollcher, agents for the Westcott and Lawrence line in Valletta; to Captain Cherry, the chief engineer and steward of the "Joshua Nicholson"; to Messrs. Rankin, Gilmour and Co., the owners, and Captain Fitzgerald, the master of the "St. Andrew"; and to Sir Cecil Hertslet, His Majesty's Consul-General at Antwerp, who has been kind enough to obtain the information required in that place.

Division II.—MILITARY.

By Major T. McCulloch, M.B., and Major J. C. Weir, M.B., Royal Army Medical Corps.

SYNOPSIS OF CONTENTS.

Division III.—CIVIL.

Division II.—MILITARY.

Section I.

The view is still current in Malta that Mediterranean Fever is, comparatively speaking, a disease of recent appearance in the island. The old contention that it was introduced by troops from the Crimea appears to have died out, but it is still asserted by some that the disease originated when the new drainage system was laid down in 1885. Hughes quotes evidence in his historical account of the disease which goes to show that, although unrecognised as a separate entity, it was one of the diseases of Malta as far back as the beginning of last century, and it is possibly of much greater antiquity. An old manuscript book in the Principal Medical Officer's office at Malta contains a health report, dated June, 1818, in which the surgeon of the 8th King's Regiment of Foot states that the regiment landed in Malta on March 2, 1818, and took up quarters in the barracks at Floriana. Soon afterwards, cases of fever began to occur, one or two being of great severity, and the description given of the symptoms bears a close resemblance in many respects to the disease as described at the present day. That Mediterranean Fever formed one of the diseases included under the heading of continued fevers in the period 1861—1870 is certain. For example, it is noted in the Army Medical Department Report for 1866 that the fevers of the year were characterised by tedious convalescence and the frequent occurrence of orchitis and rheumatism as sequelæ. It may be worth mentioning here that Hennen, who was in Malta from 1816 to 1825, in his book on the "Medical Topography of the Mediterranean," draws attention to the fineness of the goats in Malta, and to the excellence of the milk they furnished.

No attempt was made in the writings of the earlier army medical officers to distinguish Mediterranean from other fevers of continued type, and it was only after the Crimean War that the distinction began to be made. The first accurate description of the disease was given by Marston in the Army Medical Department Report for 1861, under the

heading of Mediterranean remittent or gastric remittent fever. The discovery of the *Micrococcus melitensis* in 1887 definitely established the fact that Mediterranean Fever was a distinct disease, and this was recognised by its being included in the official Nomenclature of Diseases in 1897, from which year it was given a separate place in army statistical returns. It should not be lost sight of, however, that long previous to this a very exact knowledge of the clinical features of the disease had been gained from years of observation of cases; for example, Bruce was able to obtain records of the admission of 627 cases to Valletta Hospital during the 12 years 1876 to 1887. Prior to 1897, Mediterranean Fever was included with simple continued fever in official returns under the heading of "Other Continued Fevers," enteric having been shown as a separate disease since 1882, before which year the heading of "Continued Fevers" included enteric, Mediterranean and simple continued fevers. Consequently, although records of enteric prevalence can be obtained as far back as 1882, records in which Mediterranean and simple continued fevers are separately shown only begin with the year 1897. It follows that, in making comparisons of recent with old statistics, it is necessary to do so on a "Total of Continued Fevers" basis.

Mediterranean Fever statistics require to be brought up to date, as, up to the present, the only readily available compilations are those given by Hughes, ending with 1895, and published in his book in 1897. Hughes' tables deal with the periods when it was impossible to split up "Continued Fevers" into the component parts, and they end at a time when the prevalence of continued fevers appeared to be on the decrease, whereas they have since shown a strong upward tendency. A considerable amount of attention has, therefore, been given to statistical details, and particularly to those of the period beginning with 1897, when separate Mediterranean Fever statistics were first obtainable.

1. *Continued Fevers in Malta from* 1861 *to* 1905.

The earliest statistical data relating to the prevalence of continued fevers in Malta which we have been able to find are for the period 1813 to 1818, when the admission rate was 89·1 and the death rate 1·88 per 1000. As time went on, continued fevers manifested a steadily increasing prevalence amongst the troops. Thus, in the decennial period 1836—1847, the admission ratio had risen to 207·3 per 1000, with a death rate of 1·46. In 1859, the prevalence of these fevers reached its culminating point with an admission ratio of 269·5, and this is still the highest on record; the same is true of the death rate, which was 8·85 per 1000. The following comments appear in the Army Medical Department Report for the year :—"Although there has been a slight increase in paroxysmal fevers and rheumatism, the great

difference, both in the number of cases and deaths, has been attributable to fevers of the continued type. The excess in 1859 over the previous average amounting to 62 per 1000 in the admissions, and 7·4 per 1000 in the deaths. The disease appears to have become more than usually prevalent in the second quarter of the year, to have reached its maximum in the third, but to have caused the greatest number of deaths in the fourth quarter. The fever was of typhoid type, and of a very fatal character, the deaths amounting to 1 in 28 of all the cases, while in the 23rd Regiment they were as high as 1 in 20, and in the 4th Rifle Brigade 1 in 18. On the average of the 10 years 1837—1846, continued fever proved fatal to only 1 in 141 cases." The high mortality and its occurrence at the close of the year indicate an enteric epidemic grafted on to the ordinary fever prevalence. Of the six regiments, the only corps which appears to have enjoyed a marked exemption from the disease was the 1st Battalion 21st Regiment, the only old battalion serving in the island, while by far the highest proportion of admissions, but with a moderate death rate, occurred in the 2nd Battalion 22nd Regiment, which arrived from England in the end of May, just as the hot weather set in. Overcrowded barracks and a hot dry season were accompanying conditions.

The following table shows the prevalence of "Continued Fevers" in Malta up to the end of 1905. For purposes of comparison, the ratios of admissions from all causes are given, as well as the corresponding statistical data relating to Gibraltar. The ratios are arranged in decennial periods from 1861 to 1900, followed by the quinquennial period 1901 to 1905.

Table I.

Malta.

Period.	All causes. Ratio per 1000.		Continued fevers. Ratio per 1000.		Proportion of continued fevers to admissions from all causes.
	Admissions.	Deaths.	Admissions.	Deaths.	per cent.
1813—18	—	—	89·1	1·88	—
1837—46	—	—	207·3	1·46	—
1859	1213·9	19·02	269·5	8·85	22
1860	983·0	10·59	208·6	3·87	21
1861—70	798·1	13·49	172·7	3·09	22
1871—80	857·1	9·77	155·3	2·56	18
1881—90	698·7	8·70	122·4	3·36	17·5
1891—1900	784·7	7·56	171·6	3·58	22
1901—05	646·1	6·32	174·3	2·50	27
Ratios 1861—1905	762·2	9·13	159·8	3·09	21

Gibraltar.

Period.	All causes. Ratio per 1000. Admissions.	All causes. Ratio per 1000. Deaths.	Continued fevers. Ratio per 1000. Admissions.	Continued fevers. Ratio per 1000. Deaths.	Proportion of continued fevers to admissions from all causes.
					per cent.
1813—18	—	—	—	—	—
1837—46	—	—	75·5	1·87	—
1859	949·0	7·18	107·5	2·91	11
1860	825·0	11·06	59·4	1·07	7
1861—70	742·5	8·44	72·9	1·60	10
1871—80	675·8	6·66	87·9	1·23	13
1881—90	800·4	6·01	108·9	2·24	13·6
1891—1900	718·6	4·00	20·3	1·01	2·8
1901—05	362·8	3·71	9·6	0·59	2·7
Ratios 1861—1905	692·9	6·01	65·1	1·42	9·4

The chief points which this table brings into prominence are as follows:—

1. The great prevalence of continued fevers in Malta.

2. The increase in prevalence in recent years.

3. That, although the general decennial admission ratios (all causes) show comparatively little change since 1861, there has been a gradual but steady decrease in the corresponding death rates.

4. That the decennial death rates from continued fevers for the same period show no improvement.

5. That the health of the garrison of Malta compares unfavourably with that of Gibraltar, especially as regards prevalence of continued fevers.

6. That there has been a remarkable disappearance of fevers of continued type (except enteric) from Gibraltar, and this has taken place in the course of the last 20 years.

Concerning the increase of continued fevers which occurred in the second and part of the third quarters of last century, reaching its highest point in 1859, we have nothing to say. The thirty years 1861—1890 are marked by a decreased prevalence of continued fevers, as evidenced by ratios of 172·7, 155·3, and 122·4, for the successive decennial periods. The next fifteen years showed a very considerable increase in fever prevalence, the decennial ratio for 1891—1900 being 171·6 per 1000, and this was followed by a further increase to 174·3, the average rate observed during the five years 1901 to 1905. During the thirty years' period of decrease the strength of the garrison averaged

about 5200, while the average strength for the ten years 1891—1900, was about 7800, and for the five years 1901—1905 just over 8000. At the close of the second decade of the period of decrease an unsettling factor is introduced into the question, namely, the short service system, which would cause a greater circulation of men and, therefore, a corresponding increase in the quantity of susceptible material. A reference to Chart 1 will show that this change was associated with increased prevalence of enteric fever. Indeed, during the four years, 1882—1885 enteric fever was higher than it has ever been either before or since. But the change does not appear to have exercised any immediate effect on the prevalence of the other continued fevers, *i.e.*, simple continued and Mediterranean Fevers. In fact, three of the years when enteric was so prevalent, 1882—1884, are years when the prevalence of the other continued fevers was light, while the five years 1887—1891 are remarkable as being the years showing the lowest prevalence of continued fevers which has occurred during the entire period from 1861 to 1905.

(1) *Relation to Sanitary Conditions.*—That a factor altogether outside ordinary sanitary defects must exist to account for the increase in prevalence of continued fevers in recent years seems more than probable, when it is considered that the soldier must have been living under far better conditions, and with far better sanitary surroundings, during the fifteen years 1891 to 1905 than those that obtained during the greater part of the thirty years 1861 to 1890. Yet, the 1891 to 1905 period was marked by a largely increased prevalence of these fevers. In the Army Medical Department Report for 1861, the following comment is made, in a reference to the opening of new stone barracks at Pembroke Camp, St. George's Bay, "that they must prove a valuable relief to the hitherto densely packed garrison of Malta." And, in connection with the erection of two wooden huts at Upper St. Elmo, we are informed, that they were much required, for the barracks, *generally, throughout the garrison*, are imperfect in their means of ventilation, limited in respect of their cubic space, objectionably situated for their health as an especial question, and had imperfect drainage. In another part of the report, the Principal Medical Officer, when reviewing the sanitary conditions generally, remarks that, barracks being throughout the command within the lines of fortification, old structures built by the "Knights" and connected with the defences, they are ill-ventilated and often damp, and much of the disease which occurs in the garrison is engendered by them. Consistent with their present construction, although capable of much improvement, it is thought they never can be placed on a high sanitary footing suitable to the climate; and he advances for consideration, whether the erection of quarters outside the walls, for occupation in time of peace, would not be attended with satisfactory

results, not only in a sanitary, but also in a financial view. The barracks, at this time, are also described as cheerless, badly lit and ill warmed. From very early days the overcrowded barracks were relieved in the hot season of a portion of their occupants by pitching tents, and it is several times recorded that this measure always appeared to be followed by a lessening of sickness in the barracks concerned, while it is also stated that the type of case from the tents was less severe than cases from the barrack rooms. Such, then, were some of the conditions under which soldiers were living in the early part of the thirty years' period of decreased fever prevalence, and, although sanitary improvements were made in those old barracks as years went on, no new barracks were opened between 1861 and 1896. Towards the close of this period two great sanitary advances were made, in the remodelling of the drainage of Valletta in 1885, and in the provision of a better water supply in 1887. New barracks were built and were opened at Imtarfa in 1896, Tigne in 1901, New Floriana (A, B, and C blocks) in 1903 and St. Andrew's Barracks, Pembroke, in 1905. Yet, notwithstanding general sanitary improvements in old barracks and the provision of new barracks, and that the clothing and feeding, as well as the general environment of the soldier have been altered greatly for the better since the sixties and seventies, continued fevers increased in prevalence during the decennial period 1891 to 1900, and increased still further in the five years 1901 to 1905, the ratio for the latter period being 174·3 per 1000, or 1·6 higher than the decennial ratio of 1861 to 1870. Even granting that there was still much sanitary deficiency remaining in the 1891 to 1905 period, surely it cannot be maintained that the sanitary conditions were worse than in the preceding thirty years. That sanitary improvements were exercising a beneficial effect on the general health conditions of the troops is rendered evident by consideration of the death rates from all causes (Table I), from which it will be observed that the death rate of 13·49 per 1000 for the decennial period 1861 to 1870 had fallen to 6·32 per 1000 for the five years 1901 to 1905, and that the descent has been gradual and progressive for each succeeding decennial period. Table I also shows that there has been no corresponding decrease in the fever death rates, in fact there has been little or no change, which consideration appears to indicate that sanitary improvements have not exerted any influence in diminishing the severity of type of these fevers, and, as we have seen, the incidence has increased.

(2) *Relation to Strength of Garrison.*—As already pointed out, there was a very marked difference in the strength of the garrison in the two periods. The annual average strength for the period from 1861 to 1890 was about 5200, while for the 10 years 1891 to 1900 it averaged about 7800, and for the five years 1901 to 1905 just over

8000. On examination of the yearly strengths from which these averages are calculated, it is observed that for by far the greater part of the thirty years' period the annual strength was generally under 5000 men, and often considerably under that number. In 1887 the strength began to be increased, the average strength for that year being 5499, and each year troops were added gradually to the garrison until a strength of 7055 was reached in 1890, of 7847 in 1892, and of 8292 in 1895. As no new barracks were available until 1896, accommodation for the additional 2000 to 3000 men had to be found in existing barracks, which may have meant overcrowding. Nothing happened during the first three years, 1887 to 1889, in fact they were exceptionally healthy years. But in 1890, when the strength had reached just over 7000 men, enteric fever became more than usually prevalent, and there was large enteric prevalence in 1893. The sustained increase of the continued fevers, as a whole, dates from 1892.

(3) *Cyclical Periods.*—Hughes has pointed out that continued fever prevalence appears to run in definite cycles, and he defines a cyclical period as the period which extends from one maximum year of prevalence to the next maximum year. Chart 1 shows that the years of maximum prevalence were 1859, 1867, 1872, 1879, 1885, 1892, 1898, and 1905, the intervals being eight, five, seven, six, seven, six, and seven years respectively. The first five of those cyclical periods showed decrease, the last two increase of fever prevalence. We are unable to give any exact evidence as to what determines this apparent periodicity. We do not know which of the forms of continued fever have played the chief part in it, or whether they have all had a share. We know that cyclical prevalence is observed in other diseases, and it may be the case here also, that after the main part of the susceptible material, present for the time, has been used up, an interval must pass during which fresh material is accumulating. In a military station like Malta there is necessarily frequent movement of troops; regiments and drafts are constantly coming and going. New arrivals probably always bring a fresh accession of susceptible material. In some years there is less fluctuation than in others, and the garrison is for a short period correspondingly more stable. It is easy to understand that at some periods there may be unusually large accumulations of susceptible individuals, but it is thought that this would be more likely to show itself in a military population by irregular outbursts rather than by more or less well defined cycles. For example, Chart 1 shows an outburst of fever in Gibraltar during the years 1881 to 1885, which may have been contributed to by an unusual accession of susceptible individuals. We are told, in regard to one of the years, that the garrison contained many young soldiers, and the increase of fever in the years in question occurred in a period

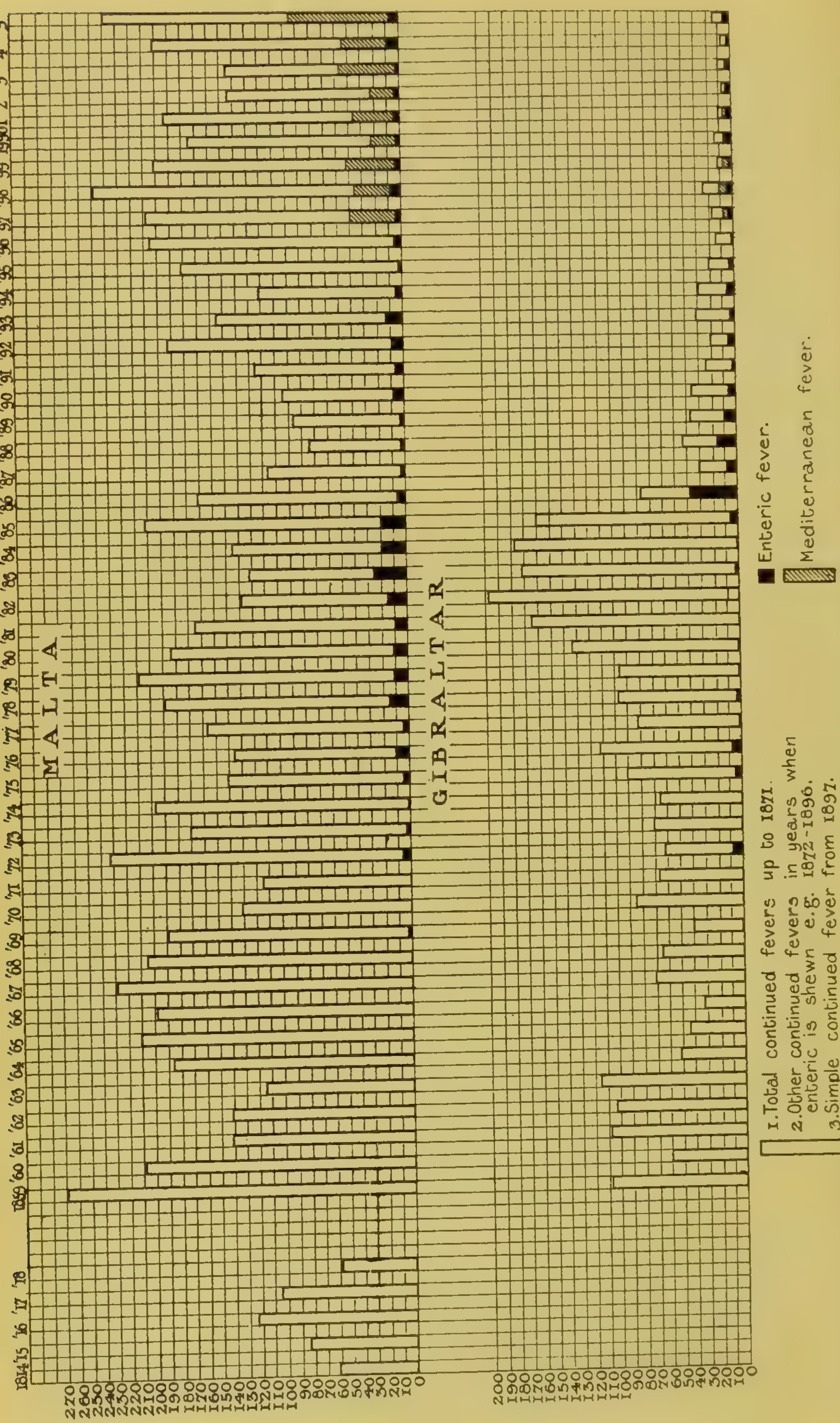


Chart 1.—Continued fevers—Malta and Gibraltar, 1859—1905.

shortly after the introduction of the short service system. Attention should be paid to the fact that cyclical periodicity is not a feature of the Gibraltar part of this chart.

(4) *Extent of Prevalence.*—During the forty-five years 1861 to 1905 the continued fevers (simple continued, Mediterranean, enteric) have been the cause of 21 per cent., or just over one-fifth, of the total admissions to hospital from all causes in Malta, and they have also been responsible for just over one-third of the total number of deaths. In Gibraltar, for the same period, these fevers have been the cause of 9·4 per cent., or just less than one-tenth, of the total admissions to hospital, and they have caused about one-fourth of the total deaths.

(5) *Comparison of Malta and Gibraltar.*—The general health of the garrison of Malta also compares unfavourably with that of Gibraltar (*vide* Table I). The decennial admission ratios from all causes are lower in the case of the latter, except for the decennial period 1881 to 1890, when the ratio was 800·4 per 1000 for Gibraltar against 698·7 for Malta. The Gibraltar death rates are uniformly lower than those of Malta. It is a notable circumstance that the ten years 1881 to 1890 show the highest prevalence of continued fevers on record for Gibraltar, whereas it was the period when the prevalence of these fevers was at its lowest point in Malta.

It will be observed (*vide* Table I) that commencing with the decennium 1861 to 1870, the prevalence of continued fevers in Gibraltar showed steady increase from 59·4 per 1000 until it reached 108·9 in the ten years 1881 to 1890, so that increase was the order of things in Gibraltar during the thirty years that decrease was occurring in Malta. In Gibraltar, during the first five years of the 1881 to 1890 period, there was a remarkable increase in prevalence of continued fevers, which then reached the highest point ever observed in this station, the highest ratio on record being that of 197·9 per 1000 for 1882, while the ratio for 1881 was 164·3, and the ratios for 1883, 1884, and 1885, were 171·4, 176·8, and 160·0, respectively. The increase appears to have been chiefly in continued fevers, other than enteric, as, although enteric was rather more than usually present in 1882 and 1885, no special enteric prevalence was observed in 1883 or 1884. During the second five years of this period the very opposite was observed. In 1886, a large outbreak of enteric fever occurred, regarding which it is stated, that the disease was introduced by a regiment which had lately come form Egypt to Gibraltar, and for the next three years enteric was unusually prevalent. During these four enteric years there was a great lessening of the other continued fevers, their prevalence being reduced to about one-fifth of what it was for the four immediately preceding years, 1882 to 1885. The figures for the decennial period are as follows :—(see also Chart 1).

Gibraltar, 1881—1890. Ratios per 1000.

Year.	Enteric fever.	Other continued fevers.	Total continued fevers.
1881	Not known	Not known	164 ·3
1882	8 ·8	189 ·1	197 ·9
1883	2 ·5	168 ·9	171 ·4
1884	0 ·6	176 ·2	176 ·8
1885	5 ·7	154 ·3	160 ·0
1886	36 ·7	40 ·2	76 ·9
1887	7 ·6	22 ·7	30 ·3
1888	15 ·4	27 ·7	43 ·1
1889	9 ·0	28 ·8	37 ·8
1890	5 ·6	30 ·5	36 ·1

Absolutely certain evidence as to the cause of the great increase of fever prevalence during the first half of this decennial period is, as might be expected, impossible to obtain, but it may be stated that it coincided in point of time with the introduction of the short service system, and Horrocks, in his paper on "Mediterranean Fever in Gibraltar" (Part V of the Commission Reports) points out the significant fact, that in 1883 practically all the goats on the Rock were Maltese, and also, that at that time regular shipments of goats from Malta to Gibraltar took place.

In Chart 1 the prevalence of continued fevers in Malta and Gibraltar from 1859 to 1905 is contrasted, and a most extraordinary contrast is observed between the fever records of the two Mediterranean stations during the twenty years 1886 to 1905. In that time, Mediterranean Fever has almost completely disappeared from Gibraltar, and coincident with its disappearance there has been a most remarkable lessening in the prevalence of simple continued fevers. On the other hand, in Malta, during the same period, there was very great prevalence of these fevers.

The disappearance of these fevers from Gibraltar began somewhat abruptly in 1886 and, as already stated, 1886 particularly, and the three following years to a less extent, were years in which enteric was more than usually prevalent. Since that time up to 1905, although the enteric ratios have been moderate, the prevalence of the disease has been steady. The conditions, therefore, which were bringing about the disappearance of Mediterranean and simple continued fevers were apparently not affecting to any considerable extent, if at all, the prevalence of enteric. It seems worth noting here that the Army Medical Department Report for 1892 gives the information that all the milk for the troops in Gibraltar was then being boiled as a preventive measure against enteric fever.

The following are the ratios for Mediterranean, simple continued

and enteric fevers for Gibraltar from 1897, the year from which the statistics are first given separately in army returns :—

Gibraltar, 1897—1905. Ratios per 1000.

Year.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1897	4·0	10·1	3·4
1898	6·3	11·2	4·2
1899	4·2	4·7	2·1
1900	2·0	6·8	4·3
1901	2·4	4·1	3·6
1902	1·0	2·2	3·1
1903	1·9	5·8	2·3
1904	—	4·8	2·9
1905	0·7	9·1	4·1

It will be observed from a consideration of these ratios, or, better still perhaps, by a glance at Chart 1, that there was a second small, but still well marked, decrease of Mediterranean fever prevalence in 1900 in Gibraltar, that the ratio was very low in the next three years, and that there were no cases at all in 1904. The ratio of 0·7 for 1905 represents only three admissions for the disease, and in regard to two of the cases it was stated that the men had lately arrived in a draft from Malta, and had in all probability contracted the disease there. The third was a man employed as a military policeman, who had been in Gibraltar for five years, and in this case the probable source of the disease could not be traced. In 1906 there have been no cases of Mediterranean Fever in Gibraltar up to the end of November.

The simultaneous disappearance of so much of the simple continued fever seems to indicate that a common factor, or factors, had been removed, or at any rate, greatly lessened, and also that many cases which were returned as simple continued fever may have been mild cases of Mediterranean Fever. The disappearance of Mediterranean Fever from Gibraltar is discussed by Major Horrocks in a paper (Part V, Commission Reports) already referred to, with which is a chart showing a probable connection between reduction of the number of infected goats and the decrease of fever. From this paper we obtain the two following important facts :—

(1) That, as a result of the withdrawal of grazing passes, the number of goats was reduced.

It was ascertained that from 1883 to 1893 about 1100 goats were sold.

(2) *Pari passu* with the withdrawal of grazing passes, and increase in the cost of shipment, importation of goats *from Malta* on a large scale ceased.

Goatkeepers replaced their stock partly by importation of Spanish goats, and partly by breeding.

Horrocks concludes his paper in the following words :—" It appears probable that the rapid disappearance of Mediterranean Fever from Gibraltar, which commenced in 1885, was intimately connected with the exodus of infected goats from the Rock. Improved sanitary conditions, especially the disconnection of waste-pipes and house-drains from sewers, may have played a part in causing the decrease of fever, but as the same sanitary improvements have been carried out in Malta without any corresponding decline of Mediterranean Fever, it is fair to assume that their effect was insignificant compared with that produced by the removal of infected goats."

2. *The Period of Separate Statistics.*

Table II gives the statistics of Mediterranean, simple continued, and enteric fevers for Malta from 1897.

Table II.

Year.	Average strength.*	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
		Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.
1897	8023	279	12	1275	—	34	15	1588	27
1898	7390	200	8	1509	1	62	24	1771	33
1899	7425	275	9	1107	—	41	17	1423	26
1900	8140	158	8	1158	—	31	11	1347	19
1901	8136	253	9	1205	—	41	11	1499	20
1902	8758	155	6	981	—	38	4	1174	10
1903	8903	404	9	781	—	18	8	1203	17
1904	9120	320	12	1350	—	79	16	1749	28
1905	8294	643	16	1199	—	64	17	1906	33
1906	6661	163†	1	504	—	9	1	676	2

* Excluding Crete. † Including 19 re-admissions.

Ratios per 1000 of Strength.

Year.	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
	Adm.	D.	Adm.	D.	Adm.	D.	Adm.	D.
1897	34·7	1·49	158·9	—	4·2	1·88	197·9	3·36
1898	27·1	1·08	204·2	0·13	8·4	3·25	239·6	4·46
1899	37·0	1·21	149·1	—	5·5	2·29	191·6	3·50
1900	19·4	0·98	142·2	—	3·8	1·35	165·5	2·33
1901	31·1	1·10	148·1	—	5·0	1·23	184·2	2·45
1902	17·7	0·68	112·0	—	4·3	0·46	134·0	1·14
1903	45·4	1·01	87·7	—	2·0	0·90	135·1	1·90
1904	35·1	1·32	148·0	—	8·7	1·75	191·8	3·07
1905	77·5	1·93	144·6	—	7·7	2·05	229·8	3·98
Ratios for 1897—1905	36·2	1·20	142·4	0·01	5·5	1·66	184·1	2·87
1906	24·5*	0·15	75·6	—	1·4	0·15	101·5	0·30

* Excluding re-admissions, the ratio is 21·6 per 1000.

(1) *Prevalence.*—An examination of the figures in Table II shows that there were 13,660 admissions for continued fevers, with 213 deaths during the nine years, 1897—1905, and that these were made up as follows :—

	Admissions.	Per cent.
Simple continued fever ...	10,565	77
Mediterranean Fever.........	2,687	20
Enteric fever	408	3

The death-rate for the nine years' period works out at 1·20 per 1000 for Mediterranean as compared with 1·66 for enteric fever. The percentage mortality to attack, in the case of Mediterranean Fever, was 3·3 per cent., against a percentage mortality for enteric fever of 30·1 per cent. A comparison of the Gibraltar figures for the corresponding period is of interest. They are as under :—

	Admissions.	Per cent.
Simple continued fever ...	277	52·6
Mediterranean Fever.........	107	20·3
Enteric fever	142	27·1

The strength of Gibraltar was over half that of Malta. The death-rate for Mediterranean Fever was only 0·07 per 1000, against 0·87 for enteric fever. For Mediterranean Fever the percentage mortality to attack was 2·9 per cent., and for enteric 26 per cent. It is curious to note that the proportion which Mediterranean Fever forms of the total continued fevers is practically the same as for Malta, and that the percentage mortality to attack is very similar for both.

(2) *The Relation of Simple Continued Fevers.*—The great prevalence in Malta of those indefinite forms of fever to which the designation "simple continued" has been applied is a very remarkable fact. We have seen that they constituted 77 per cent. of the total admissions for continued fevers during the nine years 1897 to 1905. Mild febrile attacks, dependent on a variety of causes, are of common occurrence amongst soldiers serving in hot countries, but Malta compares most unfavourably in this respect with every other garrison in which the British soldier is serving. The following table gives the comparative figures for the nine years 1897 to 1905, in the places named, which are given in order of prevalence :—

Table III.—Simple Continued Fevers.

	Total admissions, 1897—1905.	Ratios per 1000 of strength.
Malta	10,565	142·4
Egypt	2,471	64·6
Straits Settlements	574	62·2
Barbados (including St. Lucia)	346	48·2
India	17,988	30·5
Jamaica	162	29·9
Ceylon	371	27·8
Bermuda	258	15·7
South Africa—		
Four years before war, 1895–98	1,099	46·9
Four years after war, 1902–05	809	6·5
Hong Kong	17	1·3
Mauritius	5	0·7
West Coast of Africa	None	—
United Kingdom	1,793	1·9

Apart from the great prevalence in Malta of these "pyrexias of uncertain origin," as they are to be designated in the new "Nomenclature of Diseases," their undue prevalence has a direct relation to Mediterranean Fever. Many cases are admitted to hospital for simple continued fever in which the diagnosis has to be changed later to that of Mediterranean Fever. For example, in 1905, this happened in 100 instances. Over and over again, during our investigation of cases in 1906, the question of ascertaining the

exact period of onset of a case of Mediterranean Fever was rendered difficult, and sometimes impossible, by a history of a recent, or even a remote, previous febrile attack. A not uncommon type of case is for a man to be admitted for fever, but giving no serum reaction, and after a stay of a week or a fortnight in hospital he is discharged to duty as a case of simple continued fever. A week, or a fortnight, or a month later, he is again admitted with febrile symptoms, and often with a history of not having felt well or of having had rheumatic-like pains for either the whole or part of the interval. This time his blood is found to react, and the illness pursues the ordinary course of a case of Mediterranean Fever. Sometimes an attack may be preceded by two or more of these simple continued fever admissions. Or, again, there may be a history of a previous attack of fever, sometimes months before, and which may have caused a much longer stay in hospital than in the first type of case, but the clinical aspect was indefinite, and no serum reaction was obtained, and, consequently, the diagnosis of simple continued fever had to be made. On his second admission, the clinical appearances are unmistakable, the blood is found to give a typical reaction, and the case is returned as Mediterranean Fever. In some of these cases there is sometimes a connecting link between the admissions, in the shape of a history of the patient not having felt well since he was discharged from hospital after his first admission, or of having been more or less severely troubled by the rheumatic-like pains, which are so characteristic as sequelæ of an attack of Mediterranean Fever. The history in these cases leaves little doubt in the mind, that the second fever attack is a relapse rather than a first infection, and that the first admission, when simple continued fever was diagnosed, was the beginning of the patient's Mediterranean Fever. There can be little doubt, therefore, that many cases which have been returned as simple continued fever are in reality mild cases of Mediterranean Fever. This must necessarily continue to be the case as long as there is no certain means of distinguishing between these atypical cases and ordinary febrile attacks.

It will be seen from the following table that a considerable proportion of simple continued fever cases had a prolonged stay in hospital.

Table IV.—Classification of Cases of Simple Continued Fever, admitted to the several military hospitals in Malta, according to the number of days under treatment, for the years 1902—1905. The figures for 1906 are added for comparison.

Year.	Total number of cases.	5 days and under.	5 to 10 days.	10 to 15 days.	15 to 20 days.	Over 20 days.
1902	981	95	646	135	28	77
1903	781	79	457	142	52	51
1904	1350	194	867	184	49	56
1905	1199	223	676	189	50	61
Totals 1902–1905	4311	591	2646	650	179	245
Percentages ...	—	13·7	61·4	15·1	4·1	5·7
1906	504	124	311	43	11	15

It will be observed that, roughly speaking, 75 per cent. of the 4311 cases of simple continued fever admitted during the four years 1902—05 were cases requiring only a short stay in hospital, while 25 per cent. were cases of severer type, and 5·7 per cent. required over 20 days' hospital treatment. We have no exact knowledge as to the nature of the fevers represented in the last three of the five groups; many of them may have been mild or atypical Mediterranean Fever cases.

This Table also indicates that there was a large reduction in the prevalence of simple continued fevers in 1906, and especially in the 10 to 15 days, 15 to 20 days, and over 20 days, groups.

Another point which should not be lost sight of is the part which the ordinary febrile attacks may play in predisposing to attack by the severer diseases, Mediterranean and enteric.

Simple continued fevers exhibit a very decided, it might almost be called an abrupt, seasonal prevalence. A sudden increase occurs in June, prevalence reaches its highest point regularly in July, decrease commences in August, and a drop almost as sudden as the rise in June is observed with the close of September. Chart 2 (p. 140) shows the average monthly prevalence of simple continued fevers for the seven years 1899 to 1905, together with the average temperature and rainfall curves for the same period.

High prevalence of Mediterranean Fever in a unit is generally associated with high prevalence of simple continued fever cases, but a unit may have an unusual number of simple continued fever cases without any corresponding prevalence of Mediterranean Fever. The first hot

season that a regiment spends in Malta is usually marked by a high proportion of simple continued fever cases, and if it arrives close to the hot weather, or after the heat has set in, the greater is likely to be the prevalence of febrile attacks.

The barracks in which simple continued fevers have been most common in recent years have been as follows:—In 1902, Manoel, Cottonera Lines, and Lower St. Elmo barracks showed greatest prevalence. In 1903, Floriana barracks had most cases, and simple continued fever prevalence was associated with a very large outbreak of Mediterranean Fever affecting the 1st Battalion King's Royal Rifles. In 1904 a very great prevalence of simple continued fevers was associated with prevalence of both Mediterranean and enteric fevers in the 2nd Battalion Essex Regiment, which arrived in Malta from England on April 28, just at the beginning of the fever season, and were quartered in Lower St. Elmo Barracks; next in order of simple continued fever prevalence came Floriana, Verdala, Cottonera Lines, and Manoel, in all of which there was also a moderate prevalence of Mediterranean Fever, and in the three first-named barracks the occupants were newly-arrived regiments. In 1905 the greatest prevalence occurred in Lower St. Elmo, Cottonera Lines, Floriana, and Pembroke barracks, associated in all instances with marked prevalence of Mediterranean Fever. In 1906 Floriana was the barracks in which most cases were observed, and here, again, it was associated with prevalence of Mediterranean Fever. These facts would appear to indicate that simple continued fevers have a decided preference for the conditions obtaining in the old barracks, which are mostly in confined situations, and where, if overcrowding does occur, it is likely to have its worst effects. The preventive measure indicated is to spread out the men as much as possible in these old barracks during the hot weather months.

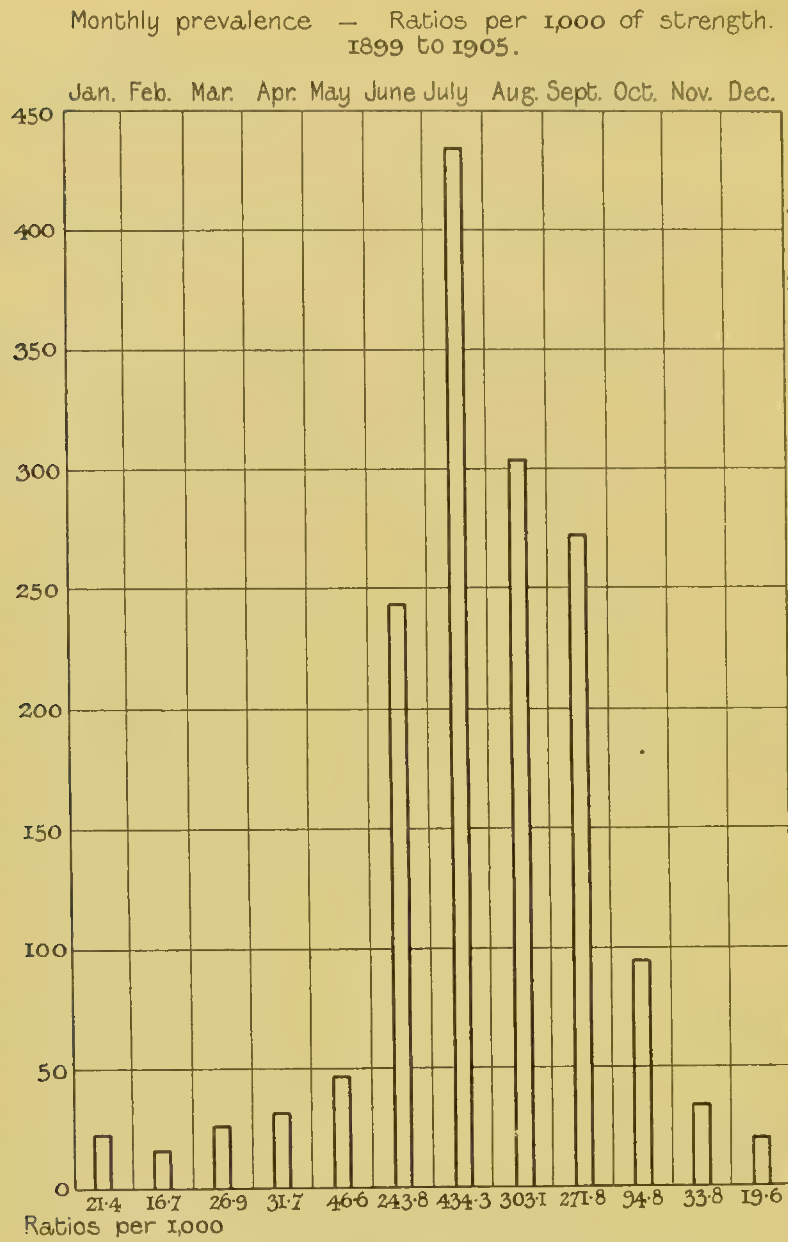
Much work still appears to be required in the direction of still further separating simple continued fevers into component parts—(1) in connection with the ordinary febriculæ, and (2) in connection with atypical cases of Mediterranean and enteric fevers, paratyphoid infections, etc.

To sum up, then, the following considerations appear to warrant the belief that a close relationship exists between many cases of simple continued fever and Mediterranean Fever, and that the bond is a common causative factor or factors.

1. The undue prevalence of simple continued fever in Malta as compared with garrisons in other warm climates.

2. The constant association of Mediterranean and simple continued fever prevalence.

3. The simultaneous disappearance of Mediterranean and simple continued fevers which has occurred in Gibraltar in the course of the last 20 years.



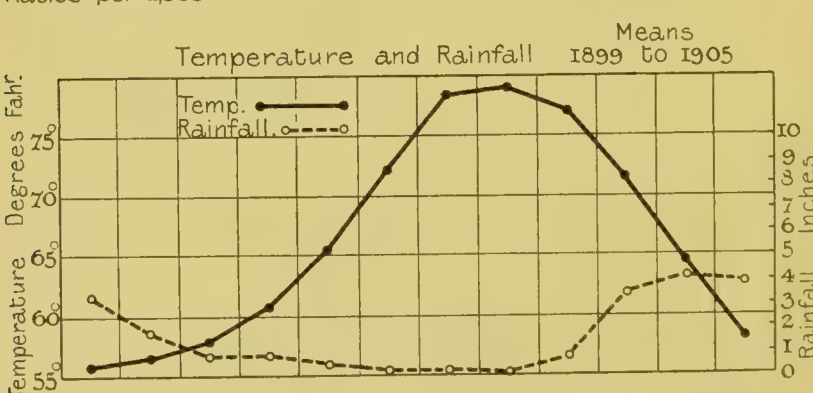


Chart 2.—Simple continued fever amongst the troops in Malta.

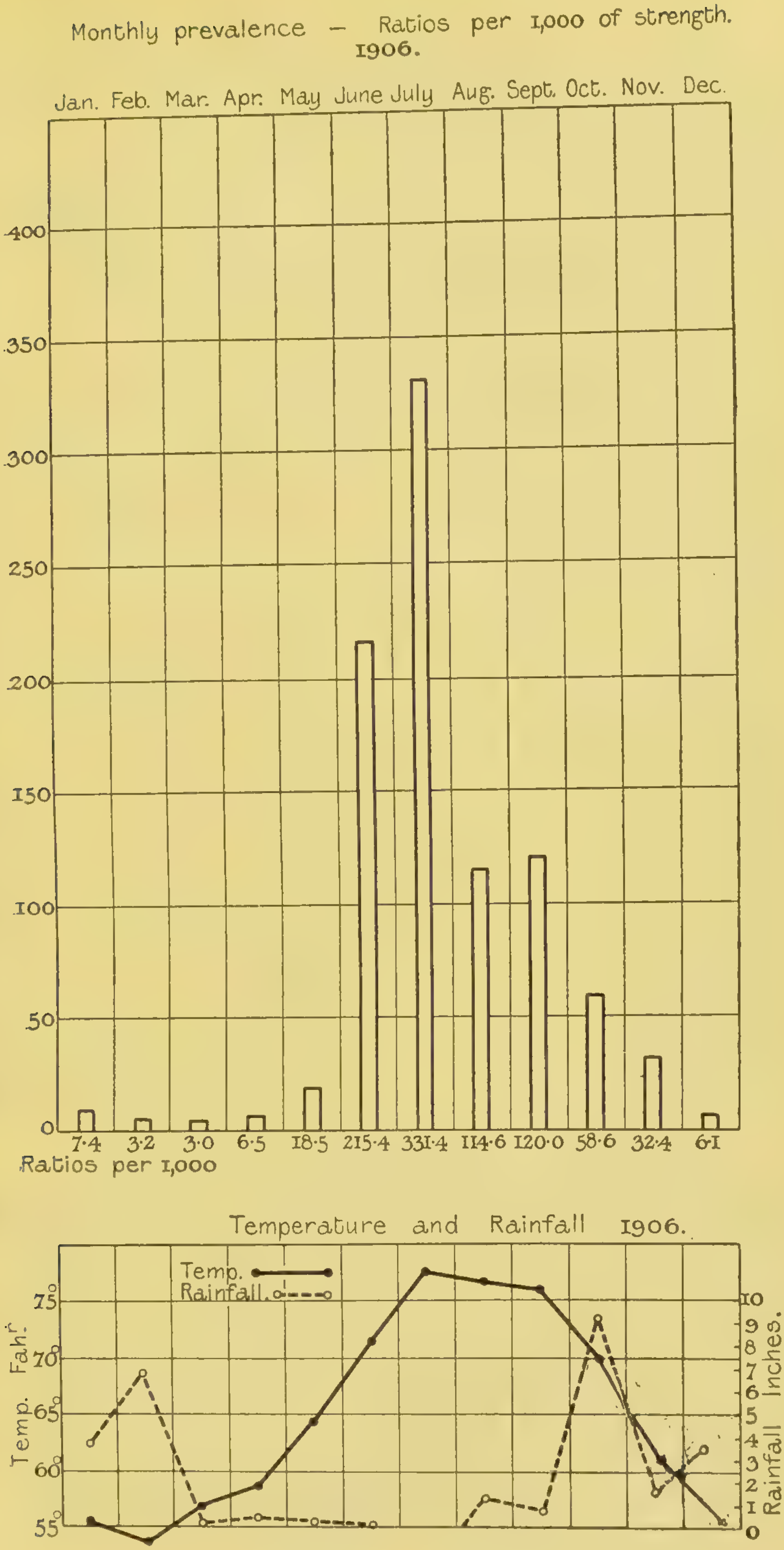


Chart 2.—Simple continued fever amongst the troops in Malta.

4. A similar reduction of simple continued fever prevalence has occurred during the second half of 1906 in Malta, in connection with a reduction of Mediterranean Fever prevalence. This will be referred to further in a later part of the Report. It is well shown in Chart 2 (p. 141).

(3) *The Relation of Enteric Fever.*—It is not uncommon to find Mediterranean, enteric, and simple continued fevers all prevalent at the same time and in the same areas. For example, the fever prevalence in the Essex Regiment in 1904 and 1905 was of this kind.

2nd Battalion Essex Regiment (arrived in Malta, April 28, 1904).

Month.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1904—			
May	—	—	1
June	7	67	1
July	19	226	3
August	20	35	1
September	18	44	1
October	7	4	6
November	7	2	2
December	1	3	6
1905—			
January	4	1	5
February	2	—	1
March	3	1	—
April	6	9	—
May	19	7	—
June	19	33	1
July	18	46	1
August	18	20	5
September	9	14	—
October	9	1	2
November	4	1	1
December	2	—	—

It will be observed that enteric was the first of the continued fevers to make its appearance among the men of this regiment, and that it began immediately on their arrival, but was most prevalent during the four months October to January, a period which had been preceded by a large outbreak of simple continued and Mediterranean fevers, and just as these fevers were beginning to show subsidence. Another example is a sharp outbreak of Mediterranean and enteric fevers which occurred in 1899, simultaneously, amongst the civil population of Rabato and the troops at Imtarfa barracks.

The following facts appear to show the existence of some relation between the two diseases, but it is a relation regarding which there is no very precise knowledge.

The *Micrococcus melitensis* and *B. typhosus* have both been recovered from the same case *post mortem.*

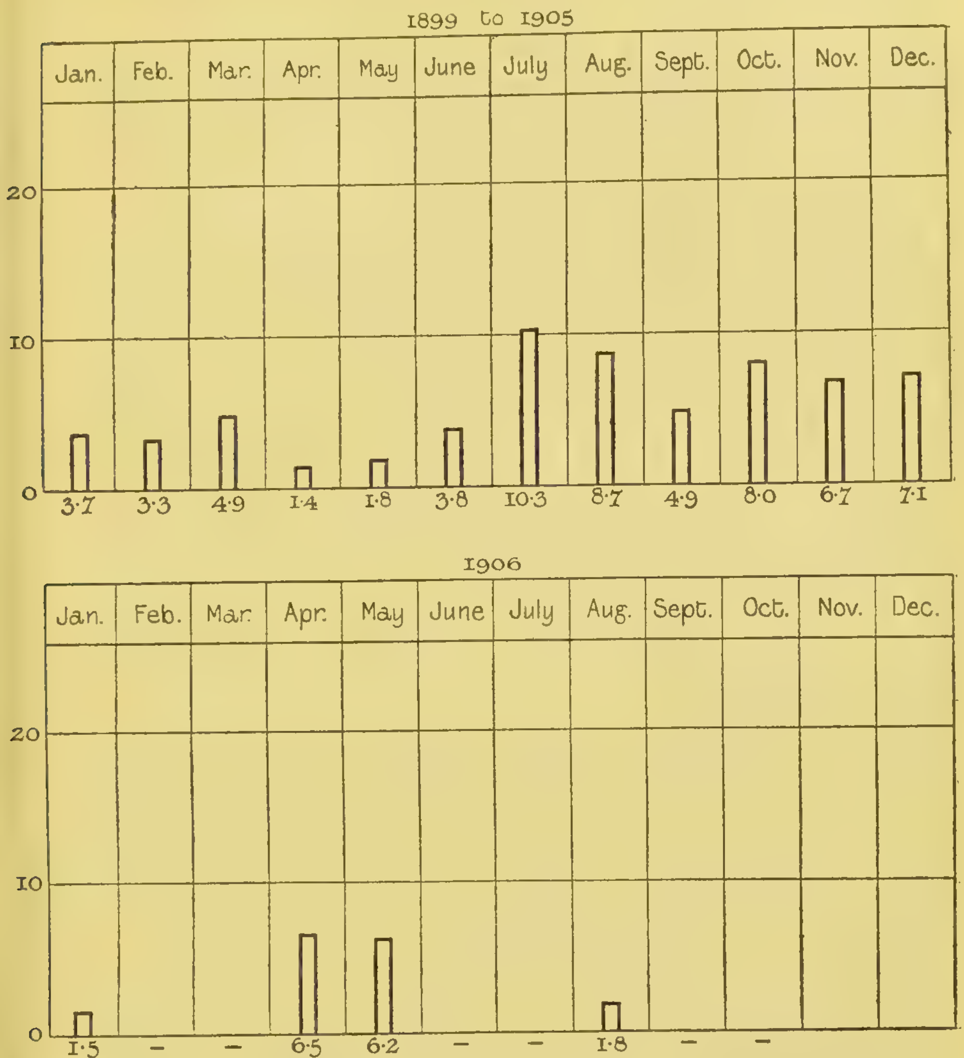


Chart 3.—Enteric fever amongst the troops in Malta.—Monthly prevalence.—Ratio per 1000.

In doing blood reactions in fever cases, the serum is not infrequently found to cause clumping of both *Micrococcus melitensis* and *B. typhosus.* We have a record of 74 instances of this occurring among the cases coming under observation in 1905 and 1906. In 24 of these instances there was a good reaction to both Mediterranean and enteric ; in one instance only was the enteric reaction the more pronounced, and in the remainder the *Micrococcus melitensis* agglutination predominated. There is no reason why the two diseases should not be drawn from sources existing quite separately at the same time and in the same areas, but the frequent occurrence of cases presenting these double reactions seems curious.

Mediterranean Fever often supervenes on enteric, but in most such cases the possibility of a fresh infection having occurred presents itself.

There has been a complete absence of enteric fever in the garrison during the second half of 1906 (*vide* Chart 3), which is the part of the year when enteric usually prevails, and this corresponds in point of time with a considerable lessening in the ordinary prevalence of both Mediterranean and simple continued fevers.

(4) *Prevalence of Mediterranean Fever in Malta from* 1897 *to* 1905.—Table II (p. 134) shows that from the beginning of 1897 to the end of 1905 Mediterranean Fever caused 2687 admissions to hospital amongst the non-commissioned officers and men of the garrison, and there were 89 deaths. During the same period there were also 241 cases with three deaths amongst the officers, 310 cases with 20 deaths amongst soldiers' wives, and 145 cases with two deaths amongst soldiers' children. The total number of admissions in the garrison during the nine years was, therefore, 3383, and the total number of deaths 115, which figures give an admission ratio of 38·0 per 1000, and a death rate of 1·29. Invaliding from Malta on account of Mediterranean Fever is high, and must be a source of large expense to the State, as in the nine years under consideration it caused the invaliding of 128 officers and 1137 men.

Year after year, with unfailing regularity, Mediterranean Fever has manifested a widespread prevalence amongst the troops, cases being contributed each year by practically every corps, and a scattered distribution in barracks being the usual rule. In some years the distribution has been a general one, while in others the prevalence has been epidemic in character. An important feature of epidemic years is that the outbreak is usually confined to single, or sometimes one or two, units, while nothing more than ordinary prevalence is observed amongst the rest of the garrison; 1898, 1905, and 1902 may be taken as examples of years showing fever prevalence of a generally distributed character, but at the same time they are years of marked contrast in regard to the extent of prevalence and the forms of fever prevailing.

In 1898 very high fever prevalence was observed, the ratio for *all* continued fevers, 239·6 per 1000, being the highest recorded since 1859, but the excessive prevalence was chiefly in cases of simple continued fever, the admission rate for Mediterranean Fever being below the average for the nine years' period. The year which comes next in regard to high fever prevalence was 1905, with a total ratio of 229·6 per 1000, but in this year the ratio of 77·5 for Mediterranean Fever is the highest on record; the ratio for the simple continued fever cases was just above the average, as was also the admission rate for enteric fever. In 1902, although there was a large garrison, fever prevalence was at the lowest point observed in the nine years under

consideration, the Mediterranean Fever rate being the very low one of 17·7 per 1000, while the admission rates for both simple continued and enteric fevers were also below the average.

The years 1899, 1903, and 1904 present good examples of localised epidemic prevalence of Mediterranean Fever. The outbreak in the Essex Regiment in 1904 has been very fully described by Dr. Johnstone in Part II of these Reports. The outbreaks in 1899 and 1903 present points of epidemiological interest which seem worth putting on record.

In 1899, a sharp outbreak of Mediterranean and enteric fevers occurred amongst the civil population of Rabato, a suburb of Citta Vecchia, and about three-quarters of a mile distant from Imtarfa Barracks. At the same time both diseases made their appearance amongst the troops at Imtarfa, most of the cases being Mediterranean Fever. The epidemic lasted three months, May to July. The civil and military authorities joined hands in an endeavour to trace the source of the disease, without result. The points of interest are: (1) The sudden onset of the outbreak; (2) the simultaneous invasion of both military and civil sections of the population; (3) the time of year, which was rather early for an outbreak, as Mediterranean Fever is usually most prevalent from June to September, and the last six months of the year is the period of seasonal prevalence for enteric. The simultaneous invasion indicates a common factor, or factors. The barracks are situated in an isolated position, on a hill at some distance from Rabato. There was no reason to suspect the water supply, as no local source of pollution could be discovered, and it was common to other places which were not attacked. The barracks were only opened in 1896, and their sanitary condition should, therefore, have been satisfactory, and we are told that nothing was discovered to which the cause of the outbreak could be attributed. The only food supply common to both civil and military was milk, and although we are not in a position to give a definite negative to all other probabilities, viewed in the light of our present knowledge, milk as the causative factor seems best to explain epidemic prevalence, sudden onset, simultaneous invasion, and early appearance. We know that Rabato is a place having many herds of goats, and that, in recent times, goats there have yielded infected milk, and, by inference, therefore, possibly also in 1899. We know that milk from the goat often contains the *Micrococcus melitensis* in enormous numbers, but that the quantities present in the milk show great variations from time to time, that they may disappear for days and reappear later, and that no obvious relation has been observed to temperature or to season of the year, either in regard to abnormal presence of *Micrococcus melitensis*, or to their disappearance altogether from an infected milk.

In 1903, a very large outbreak occurred in the 1st Battalion

King's Royal Rifles. The regiment arrived in Malta from South Africa on October 16, 1902, and were quartered in Floriana barracks until the end of April, 1904, when they moved to Imtarfa barracks, where they remained until they left for Egypt on February 27, 1905. Major Glenn Allen, R.A.M.C., who was in charge of Floriana District at the time of the outbreak, states,* that the battalion contained a fair proportion of seasoned men on its first arrival, but during the first winter its strength was increased, and the places of old soldiers sent home, time expired, were filled by the arrival of two or three drafts from the depôt. So that by the time the warm weather began there were a good many young soldiers in the ranks who, by reason of their immaturity, may reasonably have been considered as specially liable to infection.

The following table gives a complete view of the fever prevalence during the entire time of the stay of the battalion in Malta :—

Month.	Mediterranean Fever.	Simple continued fever.	Enteric fever.
1902—			
October	—	2	—
November	—	2	1
December	—	1	1
1903—			
January	3	1	—
February	—	1	—
March	3	2	—
April	—	1	—
May	—	1	—
June	5	13	—
July	13	83	—
August	47	71	—
September	61	33	1
October	45	9	—
November	19	3	—
December	13	—	—
1904—			
January	7	1	—
February	1	—	—
March	5	—	—
April	2	—	—
May	7	—	—
June	4	2	1
July	4	3	—
August	3	—	1
September	4	—	1
October	—	—	—
November	1	—	1
December	1	—	—
1905—			
January	2	—	—
February	1	—	—

* 'Journal of the Royal Army Medical Corps' for June, 1904.

During 1903 there were in all 209 admissions for Mediterranean Fever, with five deaths, and 65 men had to be invalided. The special prevalence of the disease began in June, and the epidemic was at its height in August, September, and October. It will be observed from the monthly figures, given above, that the epidemic prevalence of Mediterranean Fever cases was preceded by epidemic prevalence of simple continued fevers, and that there had been admissions for simple continued fever from the very first month of the arrival of the battalion in Malta. It is interesting also to note the almost entire disappearance of simple continued fevers that marked the last 14 months of the stay of the regiment in Malta. In August and September, cases of Mediterranean Fever were also observed amongst the women and children of the regiment who were living in quite new married quarters, A Block, Misida Bastion. The enquiries made at the time of the outbreak appear to have been negative in their result, except that it was held that "insanitary conditions" would not explain its occurrence, and the tendency was to accept the theory of air-borne infection. Building operations were going on in the vicinity, and there had been much digging and turning over of the soil, but, as Major Glenn Allen points out, "By the time the fever made its appearance among the single men the new blocks of barracks were practically completed. The disturbance of the soil, involved in digging the foundations, had taken place during the time that another battalion was stationed in the Floriana District, among whom no exceptional number of cases had occurred." Nor was there any special prevalence of these fevers in the old married quarters, which are between the new blocks and the buildings occupied by the troops in Old Floriana barracks. As no conveniences are usually provided for the Maltese workmen employed on new buildings, the theory has recently been advanced that the soil becomes extensively polluted, and that the presence of one or more ambulatory cases among the workmen might be sufficient to sow the seeds of the disease. It has to be remembered, however, that infected urine does not usually contain the specific micrococci in large numbers, consequently very gross contamination of dust should not often occur. The fact also that the *Micrococcus melitensis* is readily destroyed by exposure to sunlight, and the rapid dilution that must occur when the dust is blowing about under natural conditions, are against dust being a very common factor. Dust-borne infection might be operative in causing a few cases, but, all things considered, it would not explain an epidemic, occurring in the hottest months of the year, and of the extent of the one under consideration. The only fresh fact we can give in connection with this outbreak is that the regimental milk supply was goats' milk. The supplier informed one of us this year (1906) that he and his forebears had supplied Floriana barracks with goats' milk for the last 20 years. In April, 1904, the battalion was

moved to Imtarfa, where there was no excessive prevalence of Mediterranean Fever, and several of the cases recorded as admissions were relapses from the previous year. After arrival in Egypt on March 4, 1905, the battalion was stationed at Cairo, where there were five admissions for Mediterranean Fever during that year. All of them were men who had been with the regiment in Malta, but only one of the five is known to have had fever there. The admissions were as follows:—

	Date of admission.	Date of discharge.	Interval since leaving Malta.
			days.
H. 5963 Private J.	9/5/05	9/10/05 (invalided)	70
H. 2573 Lance-Corporal J.*	8/8/05	25/9/05	161
H. 4736 Private H.	8/8/05	28/9/05	161
G. 2589 „ L.	17/8/05	28/9/05	170
H. 4557 Boy S.	16/8/05	28/9/05	169

* Had Mediterranean Fever in Malta, 9/9/03—29/11/03.

The diagnosis in all five cases was confirmed by serum reaction. The interval between leaving Malta and the onset of illness is a long one in each case, and suggests fresh infection, but no men who had not been in Malta were attacked. The grouping of the cases, four men belonging to one company, and the closeness of the dates of the August admissions, suggest contact as a factor, especially as the second of the cases had had Malta fever previously, but the case for contact would have been better, had some man or men been attacked who had not been in Malta. It is also an open question as to whether the lance-corporal's case should be regarded as a relapse, after an interval of just over two years, or as a fresh infection. The milk supply of the battalion in Cairo was tinned milk, but the men might have had access to goats' milk outside barracks.

With reference to the epidemic and the prevalence of fevers generally in the battalion while in Malta, the epidemiological points which are of special interest are:—

(1) A large epidemic which was at its height from August to October. In 1899, epidemic prevalence occurred at Imtarfa during the three months May to July. This appears to indicate a factor outside seasonal prevalence.

(2) The epidemic prevalence of simple continued fevers, which preceded, and was associated with, the Mediterranean Fever outbreak.

(3) The remarkable absence of simple continued fevers which marked the hot weather of 1904, and which may have been the result

of the move of the regiment from the old barracks at Floriana to the new barracks at Imtarfa.

Prevalence in Barracks.—Floriana barracks are several times brought to notice for high fever prevalence during the period 1861 to 1897, but as to the exact character of the fever prevailing in such years no information is available. Simple continued fevers, no doubt, formed the bulk of the admissions, but simple continued fever is not as a rule a fatal disease, so that, as death rates were observed, the more severe types of fever, *i.e.*, Mediterranean and enteric, must also have been present. In the majority of the years of this period, Floriana does not rise above the average, and in some, notably 1864, 1865, 1867, and 1889, it is remarkable as having had a low fever prevalence. Since the years of separate fever statistics, Floriana occupied a prominent position, in regard to Mediterranean Fever prevalence, in 1897, and in 1903 there was a large epidemic; prevalence, rather above the average, was observed in 1904 and 1905, and considerably above the average in 1906; while 1898, 1899, and 1901 were years of very moderate prevalence; and 1900 and 1902 were years in which these barracks had a low prevalence of Mediterranean Fever.

Ricasoli, Verdala, Isola Gate, and Polverista barracks have each attracted special attention at different times, both for high and for low fever prevalence. Since 1897, Ricasoli has never shown more than low figures for Mediterranean Fever, although there were more cases than usual in 1905. Verdala barracks have maintained a fair reputation for moderate Mediterranean Fever prevalence in the years 1898 to 1906. Verdala has had at times a high admission rate for simple continued fevers, and it has had an enteric notoriety in the past.

Lower St. Elmo, which in 1859 was regarded as one of the most unhealthy barracks in Malta, was specially mentioned for low sickness rates in 1861, 1862, 1864, 1865, 1871, 1872, and 1889. In the Army Medical Department Report for 1872 it is stated that "Lower St. Elmo maintains its good character." But it occupied the highest place for fever prevalence in 1875 and again in 1883, while it had the second highest place in 1892. These barracks have had an enteric reputation in years past. As far as Mediterranean Fever is concerned, they have a fair repute from 1897 to 1903, but in both 1904 and 1905 they headed the list for Mediterranean Fever prevalence, while in 1898 and again in 1902 low prevalence was observed.

Manoel barracks have never shown more than moderate prevalence up to 1905, when each contributed about five times its average number of cases.

St. George's barracks, Pembroke, have usually shown moderate prevalence, but here, too, there was a considerable increase in 1905.

Even the newest, well built and well sited barracks are not exempt, as Imtarfa barracks, which are situated on a hill in the open country,

began to show fever prevalence in 1896, the year they were opened; a sharp outbreak of Mediterranean Fever occurred in them in 1899; and they again showed more than ordinary prevalence in 1905. Tigne (stone barracks), opened in 1901, the new blocks at Floriana, opened in 1903, and St. Andrews barracks, opened in May, 1905, have all contributed cases of Mediterranean Fever. The same is true of both old and new married quarters. The provision of new buildings with sanitary fittings and general surroundings far in advance of those of remote periods has not prevented the occurrence of Mediterranean Fever amongst the occupants.

The foregoing considerations show that great irregularity is manifested from year to year in regard to the extent of fever prevalence in the various barracks in Malta. There is no evidence of a persistent and constantly recurring place infection in connection with any of the barracks, except perhaps in Floriana old barracks, which, since the large epidemic of 1903, appears to have contributed more than its normal share of cases of Mediterranean Fever in 1904 and 1906, but it was better than Lower St. Elmo in 1905.

3. *Prevalence of Mediterranean Fever in Different Branches of the Service.*

The following table shows the prevalence of Mediterranean Fever in Malta, by branches of the service, during the four years 1902 to 1905.

(1) *Artillery and Infantry Compared.*—This table shows that the artillery have suffered less from Mediterranean Fever than the infantry, the ratio for the former being 28·0 against 47·2 per 1000 for the latter. The general sickness rate amongst artillery is generally better than the infantry, but this, it is thought, would be insufficient to account for the large difference in prevalence of Mediterranean Fever. One very important difference between the two bodies of men is that the artillery generally have used condensed milk, while the infantry have used goats' milk. We are not absolutely certain about the milk supply of some of the artillery units that left Malta during the early part of the four years' period, but on the assumption that they used goats' milk in place of condensed milk, it would only make the difference in the rates the more striking.

(2) *Special Prevalence of Mediterranean Fever in the Royal Army Medical Corps.*—This is obviously an important point, more particularly as a similar special liability is observed among the Sick Berth Staff of the naval hospital at Bighi.

Table V, p. 151, shows that during the four years 1902 to 1905 the incidence rate for the Royal Army Medical Corps is three times the infantry rate, 148 as compared with 47·2 per 1000. The general

Table V.

	1902—05, aggregate strength.	Mediterranean Fever.		Simple continued fever.		Enteric fever.		Total continued fevers.	
		Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.	Admissions.	Ratio per 1000.
Royal Garrison Artillery	7,571	212	28 ·0	649	85 ·7	25	3 ·0	886	116 ·7
Infantry (excluding Crete)	24,801	1,171	47 ·2	3,427	138 ·1	163	6 ·6	4,761	191 ·9
Royal Engineers	1,311	29	22 ·1	69	52 ·6	6	4 ·6	104	79 ·3
Army Service Corps	199†	12	60 ·3	18	90 ·4	1	5 ·0	31	155 ·7
Royal Army Medical Corps	527	78	148 ·0	113	214 ·4	3	5 ·7	194	368 ·1
Army Ordnance Corps ...	262	10	38 ·2	20	76 ·4	—	—	30	114 ·6
Garrison Staff	254	9	35 ·4	13	51 ·2	—	—	22	86 ·6
Militia*	250	1	4 ·0	2	8 ·0	1	4 ·0	4	16 ·0
	35,175	1,522	43 ·2	4,311	122 ·5	199	5 ·7	6,032	171 ·4

* 1902 only. † 3 years only, 1903—05.

admission rate from all causes for the Royal Army Medical Corps usually conforms fairly closely to that of the infantry, but, in that year of special fever prevalence, 1905, the medical unit had a general admission ratio of 974·2 per 1000 against 681·8 for the infantry. It is also observed that continued fevers, using the designation in its inclusive sense, caused 50 per cent. of the total admissions to hospital from all causes among the Royal Army Medical Corps, whereas in the garrison as a whole the proportion is about 21 per cent., and even that must be regarded as an excessive proportion.

From the beginning of 1902 up to the end of September, 1906, the average annual strengths of the Royal Army Medical Corps were 99 in 1902, 140 in 1903, 143 in 1904, 155 in 1905, and 164 for January to September, 1906. The actual number of non-commissioned officers and men who served in Malta during the period in question is 364, and of these three were there for the second time. Of the 364 men, 92 contracted Mediterranean Fever, their service in Malta at the time of contraction being :—

Under 1 year.	1 to 2 years.	2 to 3 years.	3 to 4 years.	4 to 5 years.	5 to 10 years.	Total.
44	24	14	6	2	2	92

These figures demonstrate the special liability of the newcomer to attack by Mediterranean Fever.

Including simple continued and enteric fevers with Mediterranean Fever, an examination of the corps records in Malta showed that a considerable proportion of men escape fever altogether, and employments which figure often in this group were wardmasters, compounders, clerks and men employed in stores.

The following table gives the admissions for continued fevers during the four years 1902 to 1905. Of the 92 cases referred to above, five were men who had contracted the disease prior to 1902, and there were nine re-admissions, hence the total of 78 admissions for Mediterranean Fever shown in the table.

Royal Army Medical Corps.

Year.	Average annual strength.	Mediterranean Fever. Admissions.	Mediterranean Fever. Ratios per 1000.	Simple continued fever. Admissions.	Simple continued fever. Ratios per 1000.	Enteric fever. Admissions.	Enteric fever. Ratios per 1000.	Total continued fevers. Admissions.	Total continued fevers. Ratios per 1000.
1902	99	3	30·3	16	161·6	1	10·1	20	202·0
1903	140	17	121·4	27	192·9	—	—	44	314·3
1904	143	19	132·9	27	188·8	1	7·0	47	328·7
1905	155	39	251·6	43	277·4	1	6·4	83	535·4
		78	148·0	113	214·4	3	5·7	194	368·1

During these four years 50 men of the Royal Army Medical Corps were invalided on account of Mediterranean Fever, and it caused two deaths, both in 1905.

Next to the great prevalence of fevers in 1905, the marked disparity between 1902 and the following years, as regards fever prevalence, is the point which shows up most prominently in this table. The most probable explanation of this is absence of the usual arrival of susceptible material, owing to the fewness of reliefs during the South African War years, 1899 to 1902. That there were very few fresh arrivals to join the corps at this period is well shown in the following analysis of the composition of the Royal Army Medical Corps unit serving in Malta at the beginning of 1902. It was composed of men who had joined as under :—

1895.	1897.	1898.	1899.	1900.	1901.
1	19	53	9	3	10

In 1902, 77 men joined the station, six of them between February and August, 70 on October 14, and one in November. With the accession of this fresh material, Mediterranean Fever began after a brief interval. There were only three admissions for the disease in 1902. The first was a man who had joined in January, 1901, and who was admitted on January 24, 1902. The next was the case of a man who, within a month of his arrival on May 21, 1902, was admitted for simple continued fever, and was almost continuously ill afterwards, until invalided on March 10, 1903; no blood reaction was obtained in this case until October 8, 1902. The third was a man of the large draft which arrived on October 14, who was admitted for Mediterranean Fever on December 19. The subsequent history of

this draft is as follows: eight of the men were admitted for the disease in 1903, eight more in 1904, four in 1905, and three in 1906, 24 cases in all out of 70 men.

The distribution of the disease in the detachments serving in the various military hospitals during the four years was as follows:—

Hospitals.

	Valletta.	Cottonera.	Forrest.	Civita Vecchia.	Imtarfa.	Gozo.
1902	3 (60)	— (52)	— (12)	— (15)	— (13)	— (3)
1903	4 (222)	8 (66)	— (32)	1 (70)	— (14)	— (0)
1904	10 (167)	6 (62)	1 (27)	1 (22)	— (28)	— (14)
1905	20 (300)	9 (143)	2 (93)	3 (32)	1 (69)	— (6)
Total	37 (749)	23 (323)	3 (164)	5 (139)	1 (124)	— (23)
Admissions, ratio per 1000 of corps strength, 1902—05	154·1	149·3	76·9	98·0	32·2	—

The figures within the brackets indicate the number of cases of Mediterranean Fever admitted during the year to each hospital. Cases were treated in each of these hospitals up to May, 1906, after which all cases of the disease were sent to Valletta. This table shows that there is no constant relation between the numbers of cases occurring among the sick attendants and the quantity of possibly infective material in the wards. For example, at Valletta in 1903 there were four Royal Army Medical Corps cases with 222 admissions for the disease, while in 1905 there were 20 cases in a year which had 300 admissions. At Cottonera in 1903 there were eight corps cases with 66 Mediterranean Fever cases, while in 1905 there were only nine when more than double the 1903 number of cases passed through the hospital. Compare also Civita Vecchia, one with 70 in 1903, and three in 1905, when there were but 32 admissions.

The monthly distribution of cases was as under:—

Royal Army Medical Corps.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1902	1	—	—	—	—	—	—	—	—	1	—	1
1903	1	—	1	1	2	2	1	2	1	1	2	3
1904	1	4	1	—	1	1	2	3	—	2	2	2
1905	3	—	1	2	3	4	8	10	2	2	1	3
1906	3	3	1	3	5	1	—	2	—	—	—	—

The monthly prevalence of the disease in the corps follows very much the same distribution as is exhibited by the rest of the garrison.

Occupation.—The duties of the 69 men at the time they contracted the disease were as follows:—

1902–03.	Men.	1904–05.	Men.	Total.
Ward duty	9	Ward duty, Nurses	19	45
		Ward duty, General duty	17	
Cooking class	3	Cooking class	5	12
Cooks	—	Cooks	4	
Stewards' stores	2	Clerks	3	
Compounder	1	District staff	2	
Steward	1	Day ward master and stewards' stores	1	
		Pack and linen store	1	
		Steward	1	
Total	16	Total	53	

Ward Duty.—Prior to 1904, all the men of the Royal Army Medical Corps employed on "ward duty" took more or less share in nursing the sick, but since 1904 these men have been divided into two classes, namely, a nursing section, the men belonging to which are specially charged with the nursing of the sick, and a general duty section, to the men of which falls the cleaning work of the wards. The nursing section man, therefore, comes into more intimate contact with patients than the general duty man; but the latter, in times of special strain, may sometimes have to lend a hand in nursing, and often men belonging to the general duty section are working as probationers, with a view to passing into the nursing section. The general duty man employed in and about the Mediterranean Fever wards must necessarily handle possibly infected clothing and bedding, and may also come in contact with infected urine in latrine work.

The evidence which tells most in support of contact as a factor in the causation of the special prevalence of the disease amongst the men of the corps in Malta is that given by Kennedy,* in which he shows that while both nursing section and general duty men employed in 1905 in 20A ward, Valletta Hospital, the ward in which Mediterranean Fever cases were treated, contracted the disease, yet no attacks occurred amongst the men of either class who were employed in other wards, where there were no such cases. There are, however, some stumbling blocks in the way of general acceptance of the view that contact with cases is a factor of primary importance. There would appear to be no constant relation between the numbers of cases

* 'Journal of the Royal Army Medical Corps' for April, 1906.

occurring amongst the sick attendants and the quantity of infective material in the wards, and the history of previous years does not always show that men doing ward duty are marked out by special liability to attack. For instance, it is observed, on analysis of the cases that occurred in 1903 amongst the detachment at Cottonera, that the employments of the eight men who contracted the disease were as follows :—Compounder, 1; in the steward's stores, 2; cooking class, 3; and ward duty, 2; but one of the latter was employed in the itch tents, and the other was a lunatic attendant. Again, the nursing sisters do not show special liability to the disease in the performance of their nursing duties. There were six cases amongst the sisters at Cottonera in 1904 to 1905, but no cases of the disease have been observed amongst the nursing sisters at Valletta, although they have had to deal with more than double the number of cases of Mediterranean Fever during the four years under discussion. It is also important to note that contact with cases of the disease is not accompanied by the occurrence of cases among the sick attendants on the hospital ship "Maine" or in the home military and naval hospitals. No such cases have ever been observed, although there must be the same contact in nursing patients and the same handling of infected clothing, bedding, and excreta as in Malta, and probably with less attention to personal precautions than is observed in the case of the nursing staffs of the hospitals in Malta. These facts seem to completely negative the view that "contact" is a factor of primary importance in the causation of the special prevalence which has been observed among the men of the Royal Army Medical Corps in Malta. The one great difference in the conditions between nursing cases of the disease in Malta and away from Malta is the complete absence of a specifically infected milk supply in the latter case, and its common presence, at all events in the past, in the former.

Cooking.—The common occurrence of cases of the disease amongst men employed in cooking in military hospitals in Malta is a significant fact, and one in which infection by milk is strongly suggested, as these men had the handling of milk before its sterilisation. Cases of this kind seem to have been of particularly common occurrence at Cottonera in the past.

Superintendence of Goat Milking.—Three cases have been observed in which this formed part of the duties of the men attacked.

Handling Infective Material.—Three out of four men belonging to the Royal Army Medical Corps who have been employed in the Commission laboratory have been attacked by Mediterranean Fever, one in 1905 and two in 1906. In their case the probabilities are strongly in favour of the disease having been contracted by the handling of infective material. It is also possible that infection sometimes occurs from handling infected clothing, bedding, excreta, etc.

Table VI.

Units.	Date of arrival in Malta.	From—	First cases of— Simple continued fever.	Mediterranean Fever.	Enteric fever.	Interval between arrival in Malta and appearance of Mediterranean Fever.
1st Royal West Kent Regiment	24/2/02	Aden	April	April	June	6 weeks
2nd Cameron Highlanders	4/5/02	S. Africa	June	August	September	3 months
2nd K.O. Yorkshire Light Infantry	28/10/02	England	December	January, 1903	November	2 „
1st King's Royal Rifles	16/10/02	S. Africa	October	„	„	2½ „
1st Royal Dublin Fusiliers	23/11/02	„	December	December	December	2 weeks
2nd Hampshire Regiment	17/9/03	Gibraltar	September	November	November	6 „
1st Royal West Kent Regiment*	15/4/04	England	May	July	June	2½ months
1st Rifle Brigade	20/4/04	„	„	June	July	6 weeks
2nd Essex Regiment	28/4/04	„	June	„	May	5 „
2nd Royal Sussex Regiment	27/6/04	„	„	July	August	4 „
1st Lancashire Fusiliers	27/2/05	Gibraltar	April	April	July	1 month
4th Rifle Brigade	16/11/05	England	February, 1906	April, 1905	—	4½ months
4th Worcestershire Regiment	2/12/05	Barbados	January, 1906	February, 1905	March, 1906	2 „
Royal Garrison Artillery—						
No. 77 Company	11/3/02	Gibraltar	April	May	May	2 months
81 „	16/10/02	„	October	August, 1903	—	8½ „
93 „	9/10/02	„	„	November	December	1 month
96 „	9/10/02	„	November	March, 1903	—	4½ months
63 „	16/10/02	S. Africa	October	December	January, 1903	1½ „
92 „	16/10/02	„	December	November	December	3 weeks
99 „	17/11/03	Gibraltar	„	March, 1905	August, 1904	15½ months
100 „	17/11/03	„	November	December	July, 1904	3 weeks
102 „	29/9/04	„	„	May, 1905	December, 1904	7 months
65 „	4/11/04	India	„	February, 1905	November, 1904	3 „
1 „	12/11/04	Gibraltar	December	December	January, 1906	1 month
5 „	12/11/04	„	May, 1905	June, 1905	July, 1905	6½ months

* Second Period of Service in Malta.

It is very significant that since the milk change, that is to say, during the last six months of 1906, there have been but two cases, both at Valletta, and both inoculated men. One was a laboratory attendant, and the other is a possible relapse. (See Cases 17 and 18, Series II, the cases in the Royal Army Medical Corps, p. 194, where the cases occurring in 1906 are discussed in detail.)

The foregoing table indicates :—

1. That no unit escapes attack by Mediterranean Fever.

2. That an interval always elapses between the arrival of a unit in Malta and the first appearance of Mediterranean Fever. That is to say, the sufferers have to come to Malta to contract the disease, they are not landed suffering from it.

3. That, in the infantry, the interval has varied from under 3 weeks to, in one instance only, $4\frac{1}{2}$ months (units whose milk supply is usually goats' milk).

4. That, in the artillery, the interval is often much lengthened, varying from 3 weeks to $4\frac{1}{2}$, $5\frac{1}{2}$, 7, $8\frac{1}{2}$, and $15\frac{1}{2}$ months (units whose milk supply is condensed milk). It will be observed that many of the artillery companies are moved on from Gibraltar to Malta, and it might be urged that the susceptible men have been exhausted during the service of the company in the former station, but exhaustion of material will not explain the point, as there has been very little Mediterranean Fever amongst the troops in Gibraltar during the years in question.

5. That simple continued fevers nearly always appear first, and that enteric fever is generally later in showing itself than either Mediterranean or simple continued fevers.

(4) *Prevalence amongst Officers, Women, and Children.*—Table VII gives the Mediterranean Fever statistics relating to officers, women, and children for the nine years 1897 to 1905. The figures for the N.C.O.'s and men are added, to give a complete view of the prevalence of this fever in the garrison throughout the period in which separate statistics become available.

It has been divided into separate periods, because during the second period the serum reaction, as an aid to diagnosis, was in routine use throughout, but this was not the case in the first four years, 1897 to 1900. Blood examinations in cases suspected to be Mediterranean Fever were carried out by individual medical officers from about 1899, but an order was published on November 6, 1900, directing that these examinations were to be made in all cases. The figures relating to the second period are, therefore, the more complete, and that is why the following remarks are confined to that period.

On making an analysis of the statistics relating to the garrison as a whole, it was found that, in proportion to strength, the liability of the officer to be attacked by Mediterranean Fever is over three times as

(*To face p.* 158.)

Table VII.—Mediterranean Fever in the Malta Garrison.

1897 to 1900.

Year.	Officers. Average strength.	Officers. Admission.	Officers. Deaths.	Officers. Invalids.	Officers. Ratios per 1000. Admissions.	Officers. Ratios per 1000. Deaths.	N.C.O.'s and men. Average strength.	N.C.O.'s and men. Admissions.	N.C.O.'s and men. Deaths.	N.C.O.'s and men. Invalids.	N.C.O.'s and men. Ratios per 1000. Admissions.	N.C.O.'s and men. Ratios per 1000. Deaths.	Women. Average strength.	Women. Admissions.	Women. Deaths.	Women. Ratios per 1000. Admissions.	Women. Ratios per 1000. Deaths.	Children. Average strength.	Children. Admissions.	Children. Deaths.	Children. Ratios per 1000. Admissions.	Children. Ratios per 1000. Deaths.	Totals. Average strength.	Totals. Admissions.	Totals. Deaths.	Totals. Ratios per 1000. Admissions.	Totals. Ratios per 1000. Deaths.
1897	269	11	—	9	40·9	—	8023	279	12	110	34·7	1·49	422	13	2	30·8	4·74	740	6	1	8·1	1·35	9,454	309	15	32·7	1·58
1898	270	19	—	10	70·4	—	7390	200	8	121	27·1	1·08	436	19	2	43·6	4·58	759	16	—	21·1	—	8,855	254	10	28·7	1·13
1899	245	20	—	8	81·6	—	7425	275	9	120	37·0	1·21	478	29	2	60·7	4·18	759	6	—	7·9	—	8,907	330	11	37·0	1·23
1900	253	17	1	15	67·1	3·95	8140	158	8	43	19·4	0·98	414	10	2	24·1	4·83	709	3	—	4·2	—	9,516	188	11	19·8	1·16
Ratios per 1000, 1897—1900......					64·6	0·96					29·4	1·19				40·6	4·57				10·5	0·34				29·4	1·28
1901 to 1905.																											
1901	341	25	1	9	73·3	2·93	8136	253	9	92	31·1	1·10	435	26	1	59·7	2·29	813	9	—	11·0	—	9,725	313	11	32·2	1·13
1902	254	26	—	21	102·3	—	8758	155	6	36	17·7	0·68	551	25	4	45·4	7·25	1120	18	—	16·0	—	10,683	224	10	21·0	0·94
1903	266	54	—	21	203·0	—	8903	404	9	133	45·4	1·01	609	70	1	114·9	1·64	1206	33	1	27·3	0·83	10,984	561	11	51·1	1·00
1904	245	25	2	14	102·0	8·16	9120	320	12	100	35·1	1·32	567	70	5	123·4	8·81	928	39	—	42·0	—	10,860	454	19	41·8	1·75
1905	217	44	—	21	202·7	—	8294	643	16	382	77·5	1·93	548	48	1	87·6	1·82	860	15	—	17·4	—	9,919	750	17	75·6	1·71
Ratios per 1000, 1901—1905......					131·5	2·27					41·1	1·20				88·2	4·42				23·1	0·20				44·1	1·30
1897–1905 ...		241	3	—	102·1	1·27	—	2687	89	—	36·2	1·20	—	310	20	69·5	4·48	—	145	2	18·4	0·25	—	3383	115	38·0	1·29

great as in the case of the man. Soldiers' wives are attacked in about the proportion of two to one as compared with the men. Children are the least liable of all to attack. The figures are as follows :—

Admission Ratios, 1901 to 1905.

Officers	131·5 per 1000 of strength.		
Soldiers' wives	88·2	,,	,,
N.C.O.'s and men ...	41·1	,,	,,
Children	23·1	,,	,,

Another very striking fact is the high mortality rate observed amongst soldiers' wives. The percentages of deaths to attacks are as under :—

Percentages of Mortality to Attack, 1901—1905.

Soldiers' wives	5 per cent.
N.C O.'s and men.........	2·8 ,,
Officers	1·7 ,,
Children	0·87 ,,

The special liability of the officer to attack is not readily explainable on a general assumption that the occurrence of the disease is usually associated with insanitary conditions. At least as much care is bestowed on the maintenance of officers' quarters and messes in a satisfactory sanitary state as is given to keeping barracks in a sound condition. He is also as a rule less exposed to possible mosquito bites than the man, as many officers use mosquito nets, whereas the men are seldom or never protected in that way. Nor can the officer be said to be more exposed to the possibility of infection by infected dust. Yet the fact remains that he is three times more liable to attack by Mediterranean Fever than the man. The milk hypothesis seems best to explain this greater liability. The officer more often eats foods with milk or prepared with milk, at messes, at clubs, or at the houses of his friends. Very likely, too, in the past, he often got unsterilised goats' milk with tea or coffee, etc., and infection may sometimes have been conveyed in cream or milk with fruits or jellies, ices, etc. Bearing in mind the extent to which the goats' milk supply of Malta contains the *Micrococcus melitensis*, if it be granted that the officer is more in the habit of consuming milk in various forms, it must equally be acknowledged that he is to a corresponding extent more exposed than the soldier to chances of partaking infected milk.

The same reasoning, only in lesser degree, may also afford an explanation of the greater liability to attack exhibited by soldiers' wives. It may also be pointed out in this connection that Table VII, facing p. 158, shows that both women and children had unusually high attack rates in 1903 and 1904, which were the years just before the dangers attending the consumption of unsterilised goats' milk were

known, while in 1905, notwithstanding that there was much Mediterranean Fever about, the incidence rate for both women and children is much lower than in the two preceding years, a circumstance which may be due to attention to instructions which were issued in that year enjoining the sterilisation of goats' milk by boiling.

With regard to the high percentage mortality to attack in the case of soldiers' wives, possible explanations may be that the women often attempt to carry on their household work too long, and only give in when they become very ill, handicapping in this way their chances of recovery, and it is also probable that all the cases do not come under observation.

(5) *Age and Service in Malta in Relation to Mediterranean Fever.*—The following tables show the relation of age and length of service to admissions, deaths and invaliding on account of Mediterranean Fever during the four years 1902 to 1905.

Table VIII.—Age in Relation to Mediterranean Fever, 1902 to 1905.

Age.	1902–05. Aggregate strength.	Admissions.	Deaths.	Invalids sent home.	Ratios per 1000.		
					Admissions.	Deaths.	Invaliding.
Under 20 yrs.	4,827	190	4	101	39·3	0·82	20·9
20 to 25 "	14,774	811	13	352	54·9	0·88	23·8
25 " 30 "	7,423	233	7	96	31·3	0·94	12·9
30 " 35 "	4,205	125	9	49	29·7	2·14	11·6
35 " 40 "	3,871	120	5	38	31·0	1·29	9·8
40 years and over	845	43	3	16	50·9	3·55	18·7
	35,945	1522	41	652	42·3	1·14	18·1

It will be observed that men from 20 to 25 years of age appear to be more liable to attack than men from 25 to 40, and that increased liability is again manifested by men over 40 years of age. The mortality is, however, markedly less for men under 30 than it is for men over that age. Men under 25 show a larger proportion of invalids than the older men, but invaliding again shows increase for men over 40, a group which has also the highest death rate. The tables for the separate years will be found in the corresponding annual A.M.D. Reports, and tables for 1902 and 1903 were given by Dr. Johnstone in Part II of the Commission Reports. On making a comparison of the statistics for 1902 with those for other years, it is observed that the garrison in 1902 contained a larger proportion of older men than usual. For instance, comparing 1902, a year of light fever prevalence, with 1905, the year presenting the heaviest known incidence of Mediterranean Fever, the figures are as follows :—

Year	1902.	1905.
Age groups.	Average strength (8758).	Average strength (8294).
From 30 to 35 years	1498	609
„ 35 „ 40 „	1593	242
„ 40 years and over	230	72

In 1902, also, there would be a more stable garrison, as owing to the South African War there would be less movement of men through incoming and outgoing troops, and therefore a proportionate lessening of susceptible material. It is of interest to note that the war years, 1900 to 1902, all showed moderate fever prevalence, taking Mediterranean, enteric, and simple continued fevers into account, and this was specially the case in regard to 1900 and 1902. The same moderate general fever prevalence was observed in 1903, although there was in that year a considerable increase in the prevalence of Mediterranean Fever. In connection with these years, also, it must be pointed out that the 1st, 3rd, and 4th Royal Garrison Regiments formed part of the Malta Garrison from the end of 1901 to April, 1904, and that these regiments were largely composed of old soldiers. The garrison regiments had a very moderate fever incidence throughout their stay in Malta, less than is usually observed in the regular infantry regiment. Coincident with return to ordinary peace conditions, increased fever prevalence made its appearance in 1904, reaching a climax in 1905.

Table IX.—Service in Malta in Relation to Mediterranean Fever, 1902 to 1905.

Service in Malta.	1902–05. Aggregate strength.	Admissions.	Deaths.	Invalids sent home.	Ratios per 1000.		
					Admissions.	Deaths.	Invaliding.
Under 1 yr.	17,820	839	14	315	47·0	0·78	17·7
1 to 2 yrs.	11,356	454	12	231	39·9	1·05	20·3
2 „ 3 „	4,016	140	8	58	34·8	1·99	14·4
3 „ 4 „	1,197	41	4	19	34·2	3·34	15·9
4 „ 5 „	712	14	—	7	19·6	—	9·8
5 „ 10 „	657	32	2	22	48·7	3·04	33·5
10 years and over	187	2	1	—	10·7	5·34	—
	35,945	1522	41	652	42·3	1·14	18·1

Fifty-five per cent. of the cases of Mediterranean Fever in these four years occurred amongst men of under one year's service in Malta, and 30 per cent. were men in their second year of service there, so that 85 per cent. of the admissions occurred amongst men who had been under two years in the garrison, and the invaliding bore almost the same proportion. Mortality is, however, much more marked in connection with cases occurring after the second year of service in Malta. This is shown by the figures in Table IX, but it is even better shown in the 1905 table, from which the following figures are taken. They represent 16 deaths amongst 643 admissions.

1905.	Death rate per 1000 of strength.
Under 1 year............	1·41
1 to 2 years	1·66
2 „ 3 „	3·15
3 „ 4 „	9·26

This would appear to indicate either that after the second year men are less able to resist the inroads of disease, or that invaliding saves a proportion of the cases belonging to the earlier periods.

In connection with deaths from Mediterranean Fever, it may be mentioned that army medical officers in Malta have observed that fever cases do badly in a season when "Sirocco" is a marked feature. The Cottonera Hospital annual return for 1897 contains the following remarks on this point :—"It was also noted what an influence sirocco winds had on the course of fevers. This is a very damp and a very depressing south-east wind, and with it came high temperatures (patients), great depression and often death."

(6) *Climate in Relation to the Prevalence of Mediterranean Fever.*—In Chart 4 the relation of temperature and rainfall to the incidence of Mediterranean Fever is shown for the years 1899 to 1906 month by month, and in Chart 5, p. 220, general curves for the period 1899 to 1905 are given. The curves in the latter chart appear to show a definite relation between temperature and case incidence, the rise of temperature preceding the increase of incidence, while the rise of the rainfall curve coincides almost in point of time with the beginning of the decline in case prevalence. If, however, the temperature and rainfall curves for the separate years are examined (*vide* Chart 4) in relation to the case incidence of the particular year, it is impossible to make out any constant relation of the kind indicated by the combined curves for the series of years. It is not even constantly true that the greatest incidence corresponds to the hottest season of the year, as, for example, it did not in 1902. Again, the climatic conditions of heat and drought are associated with a small prevalence of Mediterranean Fever in 1902, but with very great prevalence of the disease in 1905. Further, in

(To face p. 163.)

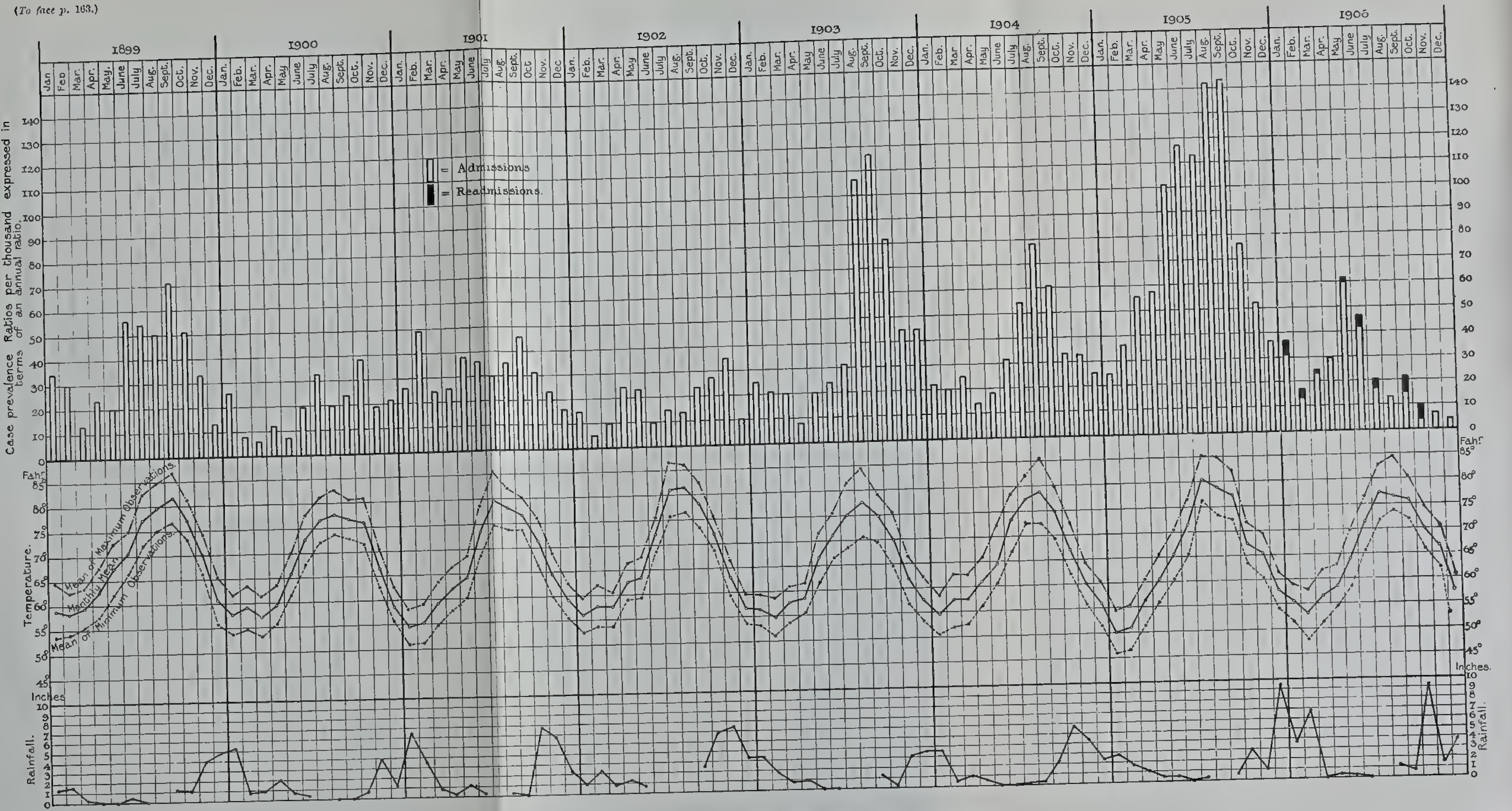


Chart 4.—Temperature and rainfall in relation to prevalence of Mediterranean Fever.

(2089)

1902, the largest number of cases occurred during the rainy season, following a period of prolonged (four months) drought, the chief prevalence being in September, October, and November, whereas in 1905 the chief prevalence was in the dry months, March to the end of September. In 1905 Mediterranean Fever reached its highest recorded prevalence. The rise began in February, shot up suddenly in May, and reached its summit in September. During this period, *i.e.*, from the beginning of February to the end of September, there was only 4·356 inches of rain out of a total for the year of 25·103 inches. By far the greatest rainfall occurred in the three last months of the year, October (3·672 inches), November (1·699 inches), and December (9·591 inches), and coincidently there was a large decrease of fever prevalence. It is observed, however, that decrease of a marked character had commenced before the occurrence of any heavy rainfall, and that the decline in prevalence continued very markedly during November, a month when little rain fell, and before the occurrence of the excessive rainfall of December. A possible explanation of such irregularities may be found in the presence or absence of an accumulation of susceptible individuals. There must be constant variation in the quantity of susceptible material in the garrison, owing to the frequent changes of the individuals forming a military population and, as already stated on p. 161, we have reason to think that absence of an accumulation of susceptible individuals marked the year 1902. It should also be remembered that the numbers of *Micrococcus melitensis* excreted in the milk of the goat are liable to great variations, which appear to have no definite relation to season of the year.

For the garrison, the period of seasonal prevalence would appear to be from May to October (*vide* Chart 5, p. 220), prevalence being at its height in August and September, while the chart also shows that the disease is present throughout the year, and that there is nothing much to pick and choose between the five months December to April, as far as moderate prevalence is concerned, at least that is the case for the period 1899—1905.

Section II.—Mediterranean Fever in the Garrison in 1906.

During the first four months of 1906 the strength of the garrison was, roughly speaking, about 8000 men. The 1st Battalion Lancashire Fusiliers left for Egypt on April 30, and they were followed there by the 4th Battalion Worcestershire Regiment on May 8, the strength in May being reduced, by the departure of these two regiments and by the departure of a detachment of the 2nd Royal Sussex Regiment for Crete, to just under 6000 men. The Worcestershire Regiment returned to Malta on June 12, and from that time up to the end of September the strength was between 6500 and 6800 men. The 1st Battalion

the Rifle Brigade left for England in October. The 1st Battalion Lancashire Fusiliers returned to Malta from Egypt on December 17, and the 1st Battalion Royal West Kent Regiment left for England on the following day.

By the departure of the Lancashire Fusiliers in April, Lower St. Elmo barracks and the Manoel hutments were cleared, but shortly afterwards a detachment of artillery was quartered in Lower St. Elmo, to relieve a somewhat congested state of the barracks at Upper St. Elmo and St. James Cavalier. Old Floriana barracks were vacated on July 11, the men of the 1st Battalion Royal West Kent Regiment, who occupied them, being moved to the Manoel hutments, partly because Old Floriana barracks have long been regarded as among the most unsatisfactory in Malta from a health point of view, and partly because there was a persistence of fever cases. All the old barracks in Cottonera Lines, which were closed in 1905, have remained closed. The small rooms in Tigne Fort still continue to be occupied, although they are most undesirable as quarters, owing to bad ventilation, especially of the lower rooms. Lieut.-Colonel Davies stated in last year's report that he had been informed that they were to be evacuated shortly. St. Francis Barracks, Floriana, were overcrowded at the time cases of Mediterranean Fever were occurring in them towards the end of May. The beds were very close together. The rooms are very high, but the question is one of giving sufficient floor space, and each man should have at least 60 square feet superficial area, and no height over 12 feet should be used in estimating the cubic space per head of a barrack room. The barrack accommodation at Valletta Hospital is insufficient for the needs of the detachment of the Royal Army Medical Corps, and a small ward had to be taken into use as an additional barrack room. With the exceptions mentioned, there was no overcrowding and, in fact, the troops were quartered under more satisfactory conditions than appears to have been the case in previous years.

There is no necessity for us to enter upon a detailed discussion of the sanitary conditions of the various barracks, as they were fully gone into last year. We made a preliminary sanitary survey of the barracks and camps, in order to make ourselves acquainted with the conditions prevailing, and we were constantly in and out of barracks in the course of investigation of cases. We are accordingly in a position to state that there was much sanitary activity in evidence, both on the part of the medical and the regimental authorities, and that the barracks generally were maintained in a satisfactory condition. It stands to the credit of Malta, that it is one of the first garrisons in which the infantry units adopted the plan of having a permanent sanitary staff under the orders of the quartermaster of the regiment. This scheme, which was commenced in the beginning of June, has worked very satisfactorily, and has in no instance hampered in any way regimental

administration or training, while it has much facilitated the task of maintaining barracks in a satisfactory sanitary state.

The water supply remains as described in previous reports. *Micrococcus melitensis* has never been found in it under natural conditions. We have no evidence which indicates it as a possible vehicle of the disease and, indeed, the scattered distribution of the cases of Mediterranean Fever in barracks, which, as in former years, was also the rule in 1906, is against water-borne infection.

1. *Drainage, Barrack Supplies, &c.*

Drainage.—There are two important changes for the better to report: one in connection with barracks, and the other affecting the drainage system of Valletta and the three cities generally. Neither of them, however, bears any relation to the prevalence of Mediterranean Fever in 1906. The first relates to the conversion of the dry earth latrines at Imtarfa Barracks to a water carriage system, the work of reconstruction having been commenced in August. The second improvement was the flushing of the entire system of town sewers twice a day instead of once as heretofore. This change was made late in the season in August. We have obtained no evidence in the course of our enquiries which would connect drainage defects with the occurrence of any case or cases of the disease.

Barrack Supplies.—Bread and meat are the only parts of the soldier's ration which are supplied by the State. All supplementary food is provided under regimental arrangements. In Malta, the bread is baked in a military bakery by men belonging to the Army Service Corps. There is a military section at the public abbattoir, from which all the meat for the troops comes, the animals having been previously inspected by the civil veterinary officer, who is in charge of the abbattoir. The groceries are purchased from the regimental grocery bars, which almost universally obtain the chief part of their supplies from English sources. The regimental institutes, such as coffee bars, etc., are generally catered for by Maltese, and the supplies usually come from Maltese sources. The grocery bars may be dismissed as selling nothing likely to have any direct relation to the causation of Mediterranean Fever. The coffee shops in barracks cannot be so lightly dismissed, as milk is used in these places. Tea, coffee, cocoa, milk, aerated waters, various kinds of cooked foods, bread, cakes, fresh vegetables, fruits, etc., are supplied. Condensed milk is the form of milk in general use in the coffee shops, but in some instances, up to the time of the milk change being made, goats' milk was used. Even after that, we have evidence that it was possible to purchase goats' milk at coffee bars in barracks, but this was probably not a very common occurrence. However, the fact that it was possible to occur at all indicates that these places require careful supervision in this respect. Neither locally made butter nor cheese has ever

been observed in any of the coffee bars in barracks. The bread and cakes are usually from Maltese bakehouses, but we have no reason to suspect them of conveying disease, and the same is true of the aerated waters supplied. Tomatoes, spring onions, lettuce, radishes, cucumbers, grapes, apricots, apples, oranges, etc., can all be purchased at these bars in their season. Tomatoes and spring onions are in common use in some barracks, especially among the artillery and engineers, and are often taken uncooked with cheese for supper. These articles are sometimes eaten unwashed, and in one instance the man told us that the tomatoes he had been eating were gritty. The possibilities of these vegetables coming from heavily manured ground, or of their lying about on contaminated surfaces in Maltese houses and courtyards, before they are brought into barracks, which we have ourselves seen, must be borne in mind, as they may be potential sources of disease. Hawkers very often bring these articles into barracks for sale, and men also purchase them outside barracks.

Soldiers' Homes.—There are Church of England homes in Valletta and at Pembroke, Wesleyan homes in the Floriana and Cottonera districts, and a Roman Catholic home in the Floriana district. Tea, coffee, cocoa and other refreshments can be obtained, and the homes are usually well managed. We were informed that the milk used was condensed milk.

Refreshment Bars, Restaurants, etc.—There are many bars and restaurants in the neighbourhood of all barracks, where the soldier can obtain suppers and other refreshments, both alcoholic and non-alcoholic, and among the latter milk has an important place.

2. *Investigation of Milk Supplies, including Milk Products.*

It is important to remember that the milk used in barracks is not supplied at the expense of the State, and that consequently the milk for the different units and officers' messes is obtained under arrangements which they themselves make. On the other hand, the milk for hospitals is a public supply, which is obtained under contract arrangements made by the officer in charge of supplies. But, whether public or private arrangements for the supply of goats' milk were the case, the milk was obtained from a large number of different sources. In the case of the hospitals, it was not always herds belonging to the contractor himself that furnished the milk, but, and this is particularly true of the larger hospitals, he gathered together a number of small owners, and from collections of goats thus made up the required quantity of milk was obtained. There was no guarantee that the herds would be composed of the same goats from day to day. Bearing in mind the extent to which the Maltese goat is the carrier of the *Micrococcus melitensis*, it is obvious that frequently changing goats must necessarily mean increased risk of the introduction of infected

milk. In the case of barracks, the herds were more uniform in their composition, and here the risk was dependent on the relative number of healthy and infected goats in the herd. This, it is thought, affords a probable explanation of the irregular distribution of the disease from year to year observed in barracks, and of the want of constancy as regards place infection.

Barracks.—During the first five months of 1906 the garrison could be divided into two sections: (1) Units using goats' milk, and (2) Units using condensed milk. To the first section belonged the 1st Battalion Royal West Kent Regiment, the 1st Battalion Rifle Brigade, the 2nd Battalion Essex Regiment, the 1st Battalion Lancashire Fusiliers, the 4th Battalion Rifle Brigade and the several detachments of the Royal Army Medical Corps. To the second section belonged the Royal Engineers, the Royal Garrison Artillery, the 4th Battalion Worcestershire Regiment, and the detachment of the 2nd Battalion Royal Sussex Regiment. This division refers only to the milk used regimentally in bulk for the men's breakfasts and teas in barracks.

Condensed Milk Units.—It by no means follows that the men of these units had no access to goats' milk. On more than one occasion we found that goats' milk was brought in for individual use in the case of units classed under the condensed milk category. The married families, too, of these units were making use of goats' milk in many instances. The milk supplies of the several officers' messes was goats' milk, or, rarely, cows' milk, which may also convey the micrococcus; and it is noteworthy that officers' servants and mess waiters showed a special liability to contract Mediterranean Fever. The fact that condensed milk was the barrack supply did not prevent the men from using goats' milk outside barracks, as a study of the histories of individual cases will show. It is a popular belief in the artillery, amongst other units, that the men did not often contract Mediterranean Fever in barracks, but that they had to be admitted to hospital to get it.

Cook-houses in Barracks.—Enquiries elicited the fact that it is a common practice for men employed as cooks to taste unboiled milk, mostly in order to decide doubts as to quality, but sometimes it was taken as a drink. Many of these men had daily opportunities of taking unboiled goats' milk, and it is a significant fact that they showed special liability to attack by Mediterranean Fever. Some instances have already been given, and others will be found in the details relating to the investigation of cases.

Use of Milk outside Barracks.—A census of the men of the West Kent Regiment was made in April as to their milk-taking habits outside barracks. The evidence obtained was that, out of 696 men questioned, 153 stated that they had drank goats' milk outside

barracks, some frequently, others occasionally. The forms in which it was taken included goats' milk plain, soda and milk, egg flips, rum and milk, ice cream, milk puddings, and occasionally milk with porridge. Besides the men referred to here, many other men in the regiment had taken tea and coffee outside, to which goats' milk had been added.

During the investigation of cases in barracks, many other parties of men were questioned, and similar information was obtained; for instance, out of a party of 36 artillerymen, 17 stated that they occasionally drank goats' milk outside barracks.

It is also fairly common for soldiers to purchase goats' milk from itinerant vendors at Pembroke Camp. It must be borne in mind, in connection with the division into goats' milk and condensed milk units, that both classes of units come to this camp for their musketry course.

Ice creams, and soda and milk are very freely taken by soldiers and by soldiers' wives and children during the hot weather months.

We satisfied ourselves by personal investigation that goats' milk was to be obtained in the restaurants, and in many of the bars frequented by soldiers. Some bars have quite a reputation for egg flips. We have also seen goats tethered in bars. There must be a demand, or a source of supply would not be on hand.

Hospitals.—The supply in all the military hospitals was goats' milk up to the latter part of May, 1906.

It was ascertained that the cooks in hospital kitchens were in the habit of tasting unsterilised goats' milk, when there was any doubt as to its quality, a practice already pointed out as also common in cook-houses in barracks, and here again cooks show special liability to attack.

In some instances, Mediterranean Fever has been contracted by men whose duty it was to superintend the milking of the goats.

Many soldiers appeared to contract the disease in hospital, and in such cases there was generally evidence that the man had been on milk diet, or that he had been getting milk as an extra.

Soldiers' Families.—A house-to-house visitation of soldiers' families was made, and it was found that some families used condensed milk alone, some both condensed milk and goats' milk, while others used goats' milk entirely. The details of this investigation are given on p. 211.

(1) *Milk Precautions, prior to the Milk Change; Barracks and Married Quarters.*—The infectivity of goats' milk was recognised in 1905, in which year orders were issued by commanding officers that all goats' milk for the use of the men in barracks was to be boiled, and the married people were enjoined to make use of the same precautionary measure. In order to prevent soil pollution, goats were ordered to be excluded from barracks, and milking places were appointed which

were usually just outside the precincts of the barracks or hospital. These instructions remained in force as long as goats' milk continued to be used.

Hospitals.—The goats' milk used in Valletta and Cottonera Hospitals was pasteurised in Aymard sterilisers, a proceeding which dates back to 1904, while in the hospitals at Forrest, Citta Vecchia, Imtarfa and Gozo sterilisation by boiling was practised. Taking Valletta Hospital as the example, the details as to milk precautions were as follows: The average daily quantity of milk used in this hospital, speaking roughly, varied between 180 and 200 pints in the cold weather months, and between 750 and 800 pints in the hot weather months. A non-commissioned officer and three men were told off to superintend the milking of the goats, and each milking was done in the presence of the non-commissioned officer and one of the men. The milk was supplied three times a day, at 6.45 A.M., at 9 A.M., and between 2 and 3 P.M.; and in the hot weather months a fourth supply was usually obtained at 6 P.M. The milk was placed in the Aymard steriliser, and it was raised to a temperature of 195° F. If the water in the outer chamber of the steriliser was boiling when the milk was put in, the temperature of 195° F. was reached in 20 to 25 minutes, and the milk was then kept at this temperature for five minutes. The whole process, therefore, takes over half an hour, and the milk has to cool afterwards. The milk cans were all scalded in the hospital kitchen. Special covered cans were used for conveying the sterilised milk from the kitchen to the wards.

(2) *Failure of Sterilisation.*—The precautions to ensure that only sterile goats' milk was supplied to the troops were excellent, as far as the issue of orders could make them, and theoretically they should have done away with all risk of the spread of the disease through the use of infected milk. But it must be remembered that such sterilisation has to be entrusted to human agency, and it was therefore likely to fail altogether at times, and if circumstances arose which might seem to require that the process of sterilisation should be hurried, it was liable on those occasions to be incompletely carried out. That it did fail is certain, as Colonel MacNeece, the Principal Medical Officer of the Malta Command, informed us that, in the beginning of September, 1905, he had to call the attention of officers commanding to the fact that in some corps goats' milk had not been boiled before use, and he asked that stringent orders might be issued that this must be done by troops and married families. Later, we again find that, while he considered the sterilisation of the hospital milk as generally satisfactory, he still regarded it as doubtful in the case of the troops, and still more doubtful in the case of the soldiers' families, notwithstanding the orders on the subject. Soon after we began our investigations, doubts as to the completeness of the milk sterilisation

became so strong in our minds that we cast about for some means of distinguishing boiled from unboiled milk, and in consultation with the laboratory members of the 1906 working party it was decided to make use of the "Ortol" test.

There are several reagents which give colour reactions with unboiled milk, such as hydroquinone, guaiacol, pyrocatechine, and ortol. The "ortol" test was suggested by Saul in the 'British Medical Journal,' March 21, 1903, for distinguishing between boiled and unboiled milk. It does not distinguish raw from pasteurised milk, as no reaction is obtained until a temperature of 75° C. is reached. Two solutions are required: (1) a solution of ortol, and (2) a solution of peroxide of hydrogen. A few drops of each, added in the order named, give an instantaneous rich rose colour with unboiled milk, no change of colour being observed if the milk has been boiled. The use of the test was started on May 16, and during the next three weeks neglect of boiling goats' milk was detected on six separate occasions. Three of these were in connection with an officers' mess in which cases of the disease had been persistently appearing. The supply of this mess was changed to condensed milk, after which no further cases occurred.

(3) *Laboratory Examinations of Milk.*—Samples of goats' milk from barracks and hospitals, of tea with added milk from barracks, and of milk and butter from an officers' mess, were examined for the presence of the *Micrococcus melitensis*, but on each occasion with a negative result.

(4) *Grouped Cases with a Common Milk Supply.*—The cases that occurred in the West Kent Regiment, both in barracks and in the officers' mess—six of the cases observed in the Misida Bastion married quarters, five cases occurring in three families living in Government quarters in Floriana, a long distance away from any of the cases just mentioned, and the case of an officer living in rooms in another part of Floriana—all had their milk from the same goat-herd. No other relation in common could be discovered, and we know that the herd contained infected goats.

(5) *Examinations of Goats.*—The work of the Commission in 1905 established the facts that a large proportion of the goats examined gave a positive reaction, and that the milk of such goats often contained the disease germ. Amongst the goats examined in 1905 were the following herds supplying milk to the troops:—

1. Valletta Hospital. A small herd of 13 goats was examined; four gave a positive reaction, and the milk of one yielded the specific micrococcus.

2. Citta Vecchia Sanatorium. There were 15 animals in the herd; 11 were found to react, and five gave infected milk.

3. Forrest Hospital. Fifteen goats were examined; five reacted, and from the milk of one the micrococcus was recovered.

The following herds were examined in 1906 :—

1. Herd supplying the 1st Battalion Royal West Kent Regiment. Owing to the prevalence of Mediterranean Fever amongst the officers and men of this regiment, and amongst the married people living in the Floriana district, the goats of the herd supplying Floriana Barracks with milk were examined in the first week in May. The same herd also supplied the officers' mess and a number of soldiers' families. This herd consisted of 40 goats, 10 of which gave a positive reaction, and from the milk of three the *Micrococcus melitensis* was separated.

2. Herd supplying the 1st Battalion Rifle Brigade. This battalion continued to have goats' milk after all the rest of the garrison had changed to condensed milk. Owing to the occurrence of cases of Mediterranean Fever in July, the goats of the herd supplying the milk were examined on the 25th of that month. The herd consisted of 81 milch goats, pregnant goats, kids, and billies. Forty-six of the goats were in milk, and six of them gave a positive reaction, and the micrococcus was recovered from one. Thirty-one specimens of blood from the other goats were examined, and 20 of them were found to react.

3. Valletta Hospital. This herd, or rather the collection of small herds which went to make it up, numbered over 60 goats. It was intended to have examined the whole herd, but owing to objection on the part of the goat-herds, samples of milk from 18 goats only were obtained. Of these six reacted, and the *Micrococcus melitensis* was isolated from one.

4. Citta Vecchia Sanatorium. Thirty-eight examined; 12 gave a positive reaction, and the milk of three yielded the germ.

5. Forrest Hospital. Eight goats were examined; all were found to be healthy.

6. Imtarfa. Sixty goats were examined, and two gave a positive reaction, but the milk of neither yielded the *Micrococcus melitensis*.

It must, of course, be remembered that some of the goats, giving reactions only, would at other times probably be excreting *Micrococcus melitensis* in their milk. From an epidemiological point of view, therefore, reacting goats must be considered as potential sources of danger.

There is evidence that the proximity to living quarters of places where goats are penned, or milked, or which are used as resting places for the goats, is attended by danger of the disease being conveyed to those living in such quarters, and we think that the fly is often a carrier of infection in such circumstances, and that the disease is more likely to be spread by it than through the medium of infected dust. This appears to be the most likely explanation of the occurrence of the disease in Cases 29 and 30 of the West Kent series (*vide* p. 187).

It is possibly also the best explanation of the cases which occurred in 1904 and 1905 among the nursing sisters at Cottonera. Davies informs us on p. 151, Part IV, of the Commission Reports, that it had been the practice, until July, 1905, to milk the goats that provided milk for the patients on a plot of ground within a few yards of the nursing sisters' quarters, and that there is no doubt that this area was extensively fouled every day for a long period. No cases have occurred amongst the nursing sisters at Cottonera Hospital since the goats were removed from this spot.

(6) *Discontinuance of the use of Goats' Milk in Hospitals and Barracks.*—Even if there had been no other facts to go on than that a large proportion of the goats in Malta were infected, and that their milk was a common vehicle for the *Micrococcus melitensis*, we consider that we would have been justified in recommending the discontinuance of the use of goats' milk. But, as early as the beginning of May, the evidence collected had lent strong support to the view that infected goats' milk was a factor of the highest importance in connection with the spread of Mediterranean Fever. The use of milk was a factor which assumed special prominence in the investigation of cases of the disease. It seemed best to explain the occurrence of cases amongst cooks, officers' servants, hospital patients, etc. It was the one common factor that appeared to be associated with the widespread distribution of the disease, and it was the one common vehicle which is known to convey the specific micrococcus. Moreover, we had completed the milk census of the West Kent Regiment, and, as the result of special prevalence of the disease in that regiment, the herd supplying the milk had been examined and had been found to be infected. There was, therefore, the association of an infected herd of goats with the special prevalence of the disease in a particular body of men. Doubts had arisen as to the efficiency of milk sterilisation, more especially in barracks, but milk infection was a certainty. The obvious course, therefore, was to cut off the supply of the infected article, both from barracks and hospitals. In discussing the matter with officers and others in barracks, we had frequently been met with the remark, "But, if goats' milk is dangerous, why is its use continued in hospitals"? We found that the regimental authorities were unwilling to move in the direction of change until a lead had been given by the hospitals. The situation was discussed with the Principal Medical Officer, Malta, who referred the matter to the Commander-in-Chief, and, on May 12, orders were issued for the discontinuance of the use of goats' milk in the military hospitals, as a tentative measure, and for its replacement by condensed milk. This change came into operation in the various hospitals between May 18 and 22, and at the same time the use of goats' milk by the various detachments of the Royal Army Medical Corps also ceased.

As the milk supply to barracks and to officers' messes is not a public supply, but is one arranged for by the units themselves, it was decided to try first to get commanding officers to make the change from goats' milk to condensed milk themselves, and also that they should be communicated with direct in the matter, rather than through the medium of orders. Accordingly, direct representations were made to the various commanding officers, but before any practical steps were taken the accomplishment of the desired change was greatly facilitated by the occurrence of a strike of the goat-herds. The strike began on May 15 and ended on June 1. It was distinctly useful in getting the use of goats' milk discontinued in both barracks and officers' messes, as the goat-herds themselves stopped supplies, and they had only themselves to blame when they found that their customers, having made other arrangements, refused to go back to them. The supply of goats' milk was not cut off completely during the strike, as one regiment, at least, got its usual supply throughout the period. There was still some hankering after goats' milk on the part of some units, but at the request of the Principal Medical Officer a lecture was given on the subject of Mediterranean Fever to the officers and warrant and non-commissioned officers of the garrison. This was followed by the almost universal adoption of the milk change, and also by another useful step, namely, the establishment of permanent sanitary staffs in connection with several of the infantry units. By the end of the first week in June all the units of the garrison were using condensed milk, with the single exception of the 1st Battalion Rifle Brigade, which continued to use goats' milk up to the time the battalion left Malta for England in October. This regiment was not pressed to make the change, as it was known to have very complete arrangements for the sterilisation of the milk, and from the personal equation point of view it was felt that the individuals concerned in the supervision of the sterilisation could be trusted. There was also the further reason that it to some extent provided a control, which might in the end prove useful for purposes of comparison in connection with the milk change. In this connection it is a significant fact that cases of Mediterranean Fever were admitted from the 1st Rifle Brigade in July, August, and October, whereas the 4th Rifle Brigade, which occupied the neighbouring barracks of St. George's, Pembroke, and which had adopted the condensed milk change, had its last admission for the disease in May.

3. *Distribution of Cases in* 1906.

Table X.

Units.	Date of arrival. From—	Barracks.	Distribution of cases by months.											
			January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1st Bn. Royal West Kent Regiment	15/4/04 England	Floriana	7	3	6	6	8	10	—	2	2	—	—	—
1st Bn. Rifle Brigade	20/4/04 England	St. Andrews	1	—	—	—	2	—	3	1	—	1	—	—
2nd Bn. Essex Regiment	28/4/04 England	Imtarfa	—	—	1	1	2	2	—	1	1	1	—	—
2nd Bn. Royal Sussex Regiment ...	27/6/04 England	,,	—	—	—	—	—	—	—	—	—	—	—	—
1st Bn. Lancashire Fusiliers	27/2/05 Gibraltar	Lower St. Elmo and Manoel	2	1	3	—	—	—	—	—	1	1	—	—
4th Bn. Rifle Brigade	16/11/05 England	St. George's	—	—	—	1	4	—	—	—	—	—	—	—
4th Bn. Worcestershire Regiment	2/12/05 Barbados	Verdala	—	1	—	1	—	—	—	2	—	—	—	1
Royal Engineers	—	St. Francis	1	—	—	1	2	3	—	—	1	1	1	—

Royal Garrison Artillery— No. 1 Company	12/11/04 Gibraltar	Tigne	1	—	—	1	—	1	1	—	—	—	—	—
5 "	12/11/04 Gibraltar	Ricasoli	4	—	1	—	—	—	—	—	—	—	—	—
63 "	16/10/02 South Africa	"	1	—	1	1	—	—	—	—	1	—	—	—
65 "	4/11/04 India	Upper St. Elmo and St. James Cavalier	1	—	—	—	3	—	2	—	1	—	—	1
96 "	9/10/02 Gibraltar		1	—	1	1	—	1	—	—	1	—	1	—
99 "	17/11/03 Gibraltar	Tigne	2	—	—	1	1	3	2	1	—	1	—	—
100 "	17/11/03 Gibraltar	Ricasoli	1	—	1	1	—	—	—	—	—	—	—	—
102 "	29/9/04 Gibraltar	Tigne	—	3	—	—	3	—	3	1	—	—	—	—
Army Service Corps	—	—	—	—	—	1	—	—	—	—	—	—	—	—
Royal Army Medical Corps	—	—	3	3	1	3	5	1	—	—	2	—	—	—
Army Ordnance Corps	—	—	—	—	—	—	—	1	—	—	1	—	1	—
Army Education Department	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Miscellaneous	—	—	—	—	—	—	—	1	—	—	—	—	—	—
	Total admissions		25	11	16	18	30	23	11	8	11	5	3	2
	Excluding re-admissions		21	8	15	18	29	21	9	8	8	2	3	2

In five of the cases debited to January, and in one debited to February, the diagnosis was then made, but the men were admitted to hospital in the previous year. These cases have been included in the 1906 figures, as they did not appear in the 1905 returns.

1. Private P., F Company, Royal West Kent Regiment.—Admitted October 5, 1905, from Room 3, Old Floriana Barracks. He had been employed in the cook-house for two months before admission. He was on milk in hospital from December 4 to December 12, 1905. A positive serum reaction was first observed on January 26, when Mediterranean Fever was diagnosed.

2. Private L., G Company, Royal West Kent Regiment.—Admitted for simple continued fever on November 13, 1905, to Cottonera Hospital, and transferred to the sanatorium at Citta Vecchia on December 24, where Mediterranean Fever supervened 21 days after transfer. He was on milk in Cottonera Hospital from November 22 to November 30, 1905, and again at Citta Vecchia from January 2, 1906.

3. Gunner S., No. 1 Company, Royal Garrison Artillery.—Admitted for bronchitis on December 31, 1905, and disease was changed to Mediterranean Fever on January 18, 1906.

4. Private E., 1st Battalion Rifle Brigade.—Admitted for rheumatism on December 31, 1905, from F Block, St. Andrew's Barracks. The disease was changed to Mediterranean Fever on January 21, 1906. There is a history that this man drank goats' milk freely prior to admission.

5. Gunner S., No. 65 Company, Royal Garrison Artillery.—Admitted for gonorrhœa on December 31, 1905, from Room 40, Upper St. Elmo Barracks. The disease was changed to Mediterranean Fever on January 10, 1906.

6. Bombardier S., No. 102 Company, Royal Garrison Artillery.—Admitted for psoriasis to Valletta Hospital on October 17, 1905, and transferred on December 6 to the sanatorium at Citta Vecchia, where symptoms of Mediterranean Fever were observed on February 6, 1906, and a positive serum reaction was obtained four days later.

Distribution of Cases.

Of the 163 admissions for Mediterranean Fever in 1906, 19 were re-admissions for the disease. The re-admissions were distributed in units as follows:—1st Royal West Kent Regiment, six; Royal Garrison Artillery, five; 1st Lancashire Fusiliers, four; 2nd Essex Regiment, three; and Army Ordnance Corps one—and in point of time: January, four; February, three; March, one; May, one; June, two; July, two; September, three; and October three.

Excluding re-admissions, the cases which occurred in the four quarters of the year were as follows:—

January to March.	April to June.	July to September.	October to December.
44	68	25	7

Two points should be borne in mind in regard to these figures—(1) that the second six months is the half of the year when Mediterranean Fever is usually most prevalent, and (2) that the first six months was the period *before* the milk change, while during the

second six months goats' milk had been discontinued in all the hospitals, and in all but one of the barracks.

4. *Prevalence in Units.*

Royal Garrison Artillery.—As has already been indicated, and as will be seen later when the individual cases are being discussed, a considerable number of the cases which have occurred in the artillery units were those of men who have taken goats' milk either in or outside barracks, while some of the others are instances in which there is a strong probability of the disease having been contracted in hospital. The artillery units show a very marked decrease of prevalence during the second half of the year, with 16 admissions against 35 in the first six months.

1st Battalion Rifle Brigade.—This battalion arrived in Malta on April 20, 1904, from England. They were quartered in Manoel Barracks for the first 13½ months, and were moved in June, 1905, to the newly built St. Andrew's Barracks, of which they were the first occupants. Mediterranean Fever appeared in the regiment six weeks after its arrival, and cases occurred every month afterwards up to January, 1906. There was then freedom from fever cases until May. On the occurrence of three cases in July, the goats supplying the battalion with milk were examined, and the herd was found to be infected. It is of course possible that the disease was contracted outside barracks, but we failed to trace any outside source, and as we know that the milk was coming from an infected herd of goats, notwithstanding the very strict supervision exercised over the boiling of the milk in this battalion, failure of sterilisation cannot be excluded.

4th Battalion Rifle Brigade.—This battalion arrived from England on November 16, 1905, and were quartered in St. George's Barracks, Pembroke, which are in the near neighbourhood of the barracks of the 1st battalion of the regiment. The first case of the disease occurred four and a half months after arrival, and there have been five cases in all, one in April and four in May. There have been no cases since the milk supply of the battalion was changed to condensed milk.

2nd Essex Regiment.—Arrived in Malta from England on April 28, 1904. This regiment suffered severely in both 1904 and 1905, when it contributed 79 and 113 admissions respectively. During the first 14 months of its stay it was stationed at Lower St. Elmo, after which it was moved to Imtarfa, where it has since remained. There have been only nine admissions in 1906, six in the first half of the year and three in the second. Of the latter, one was a case from Gozo, and both in this and one other of the three cases there is a history of taking goats' milk. The milk supply of the regiment was changed from goats' milk to condensed milk on June 7.

1st Battalion Lancashire Fusiliers.—This regiment came from Gibraltar to Malta on February 27, 1905, and the first cases of Mediterranean Fever were admitted in the following April, and cases occurred every month until the regiment left for Egypt on April 30, 1906. There were 75 admissions in 1905, while in 1906 there were eight admissions, four of which were re-admissions, two in the first three months of the year and one each in September and October. Two cases of Mediterranean Fever were admitted in Egypt on July 7, one from the officers' mess and the other from No. 5 Room, L Block, Citadel Barracks. Both men arrived from Malta on May 3. Cows are kept at the Citadel Barracks, and this milk is not boiled before issue. We have no information as to the presence or absence of the *Micrococcus melitensis* in milk in Egypt. The regiment returned to Malta from Egypt on December 17.

2nd Battalion Royal Sussex Regiment.—The headquarters and 500 men of this regiment left Malta for Crete on May 29, 1905. A detachment remained and were quartered in Imtarfa Barracks until April 30, 1906, when it left Malta to join headquarters. There were no cases of Mediterranean Fever in 1906 up to the time of its departure. The milk supply was condensed milk.

4th Battalion Worcestershire Regiment.—This regiment arrived in Malta from Barbados on December 2, 1905, and were quartered in Verdala Barracks. The first case of Mediterranean Fever was admitted on February 11, 1906, but we have no evidence as to the probable source of the disease, except that the man was in hospital from December 2 to 12, 1905. The second case was admitted on April 16, and was that of a married man, whose child was admitted for Mediterranean Fever on March 2, and for both cases there is a goats' milk history. The milk supply of the regiment is condensed milk, dating from its arrival in Malta. The regiment was sent to Alexandria, where it arrived on May 11, and it returned to Malta on June 12. Six cases of Mediterranean Fever were admitted during its month's stay in Egypt. There was an entire absence of Mediterranean Fever from the garrison of Alexandria until the arrival of the Worcestershire Regiment from Malta, and the only cases then observed were those among the men of that particular regiment. We have been unable to obtain any evidence which throws any light as to the source of the disease in these six cases. The men appear to have been admitted for simple continued fever in four of the cases and for rheumatism in the other two, and the disease was changed afterwards to Mediterranean Fever. A positive serum reaction was obtained in each of the six cases. After returning to Malta, two more cases were admitted in August; one was a man who had been feeling out of sorts ever since his return from Egypt, the other was a man admitted on August 13 from Gozo, where he had

been stationed since July 2, and where he had been employed as a cook. There is no evidence of the use of goats' milk in either of these cases. Another case was admitted in December, but of this case we have no particulars.

The units showing the greatest prevalence of Mediterranean Fever in 1906 were the 1st Battalion Royal West Kent Regiment and the Royal Army Medical Corps, the special prevalence, however, being confined in both instances to the first half of the year. The details are given fully in the following section of the report dealing with the analysis of cases of Mediterranean Fever.

5. *Analysis of Cases of Mediterranean Fever.*

Though the analysis of the cases generally only gives brief details, yet each case was examined in a systematic manner on a special form arranged for the purpose. We found the forms of very great assistance in recording cases. The principal points noted in each case were: 1. The barrack room or place from which each case was admitted. 2. The date of the onset of attack, together with a history of the man's previous state of health, and the date on which his blood reacted against *Micrococcus melitensis.* 3. Date of admission. 4. Whether a first attack or relapse. 5. Movements since arrival in Malta, giving dates which were confirmed by reference to official information obtained from the unit to which the man belonged. 6. More particular information about the man's movements during the 30 days before he got ill. 7. Particulars of previous illness in Malta from his medical history sheet. 8. If single or married, in the latter case enquire *re* health of other members of family. 9. Conduct and habits, teetotaller, moderate drinker, drinks freely, and enquiries as to visits to brothels, giving dates. 10. Actual nature of employment: on this point we found it to be of the very greatest importance to get full information, as it gradually came out that certain employments were found to be frequently associated with attacks of Mediterranean Fever; for example, cooks, mess waiters, and officers' servants. 11. Any special hard work or exposure during 30 days before illness. 12. Any facts bearing on defective drainage, dust, latrines, urinals, etc. Whether employed in cleansing W.C.'s., urinals, or moving urine tubs during 30 days preceding illness. 13. Facts concerning milk consumed, including butter, cheese, or other articles into the composition of which milk enters. If the man had consumed any fresh goats' or cows' milk during the 30 days preceding; give dates if possible. 14. Apart from barrack ration meals, particulars relating to articles partaken of in barracks, such as milk, other foods, uncooked vegetables, fruits, aerated waters, etc. 15. Articles of like nature partaken of outside barracks

and where; dates if possible. 16. Facts relating to mosquitoes and other biting insects (*a*) in barracks; (*b*) out of barracks. 17. What contact has there been with recent cases of the disease (*a*) personal? (1) Contact with previous cases before their removal to hospital. (2) Presence of convalescents in barrack rooms; this included blood examination and, in some cases, examination of urine. (*b*) Through clothing and bedding. (*c*) Issue of articles from store. 18. Position of bed in barrack room and relation, if any, to previous cases. 19. Precautionary measures adopted with regard to previous cases. 20. Miscellaneous facts in relation to each case.

During the year 1906, up to the end of September, 153* cases of Mediterranean Fever had occurred among the non-commissioned officers and men of the British troops in Malta. Of these, 108 are possible cases of infection through goats' milk, *i.e.*, 70·6 per cent. of the cases. They are cases (1) of men who are known to have drunk goats' milk freely, the source of which was known later to have been from a herd which contained infected goats. (2) Of men who are known to have drunk freely goats' milk about the source of which nothing is known, beyond the fact that they got it from a passing goat-herd, or in a restaurant, or in the houses of private individuals. (3) Of men who had taken goats' milk in egg flips or with rum in different public-houses. (4) Of cooks who said they only drank it boiled. (5) Of men who drank goats' milk in hospital. (6) Of men who said they only had it in tea other than the regimental tea. (7) Of men who said they only had it in tea in barracks.

The last group is a small one, but, we believe, not an unimportant one, though we have not classed any of these cases among those of probable milk infections. The incidence of the disease on goats' milk-drinking regiments is an argument in favour of the inclusion of such men as possible cases of infection through milk. The 1st Rifle Brigade in St. Andrew's Barracks, the newest and best run barracks in Malta, gave nine cases of Mediterranean Fever during the year. This regiment continued to use goats' milk for the men's tea until they left Malta on October 1, 1906. The 4th Rifle Brigade, which lay near the 1st Rifle Brigade in St. George's Barracks, gave five cases of Malta Fever. This regiment discontinued the use of goats' milk on May 15, and their last case of Malta Fever was admitted to hospital on May 29, 1906 (Private M.). The last case from the 1st Rifle Brigade was admitted to hospital on October 19 (Private P.).

The Royal West Kent Regiment had 44 cases. This regiment discontinued the use of goats' milk on May 15. Up to June 15, 35 cases took place, or 79·5 per cent. of all the cases, while only nine

* The total number of cases for the year is 163, the 10 further admissions occurred after we had left Malta.

cases, or 20·5 per cent., took place between June 15 and the end of September, the time of greatest prevalence in past years. These figures really understate the case, as two out of the nine cases include two relapses, one, Private H. H., a relapse from June 15, 1906, and Corporal T., a relapse from November 27, 1905, and another man, Lance-Corporal R., who was admitted on July 9, 1906, used to get goats' milk to the middle of June, and must therefore be included in the list of possible milk infections. The figures thus corrected give 86·4 per cent. of possible milk infections.

The Royal Army Medical Corps gave 18 cases up to the end of the year. The use of goats' milk was discontinued at Valletta Hospital on May 21, at Cottonera Hospital on May 22, 1906, at Forrest Hospital on May 18, 1906. Fifteen of the 18 cases occurred before or a few days later than June 22, while of the remaining three cases, one, Private J., admitted on June 19, 1906, but ill since June 11, 1906, acknowledged that he had drunk unboiled goats' milk about a fortnight before the condensed milk was taken into use, *i.e.*, on or about May 8, and another of the cases was that of Lance-Corporal J., who was almost certainly infected while working in the laboratory of the Mediterranean Fever Commission, and the last was the case of Private B., admitted September 16, 1906, but who had been feeling unwell practically since May. (See Case 18, Royal Army Medical Corps.) It is thus seen that 88·9 per cent. of the Royal Army Medical Corps cases occurred before goats' milk was stopped in the hospitals. The Royal Army Medical Corps furnished 11·4 per cent. of all the cases during the year.

Though we do not think that all these cases were milk infections, it is a striking fact that so many cases occurred during the time goats' milk was in use in the hospitals, and so few after its discontinuance.

The cases have been divided into the following groups :—

Series 1.—The cases in the 1st Royal West Kent Regiment.

Series 2.—The cases in the Royal Army Medical Corps.

Series 3.—Hospital cases.

Examination of the Diet Sheets of patients in Valletta Hospital during 1905.

Series 4.—Other cases of possible milk infection.

Series 5.—Cases in which the patients were probably infected through animals other than goats.

Series 1.—*The Cases in the* 1*st Battalion Royal West Kent Regiment.*

This regiment, as in the previous year, occupied Old Floriana Barracks, New Floriana Extension, and Notre Dame Ravelin Barracks and Huts, and Salvatore Counter Guard. The structural arrangements and sanitary shortcomings of the old barracks have been fully detailed by

Lieut.-Colonel A. M. Davies in last year's Report, and need no recapitulation here. Suffice it to say that the local authorities had done their best to remedy such defects as were remediable, and had taken good care, by provision of ample tentage, that no overcrowding took place in the casemate rooms. Further, on the recommendation of Colonel MacNeece, Principal Medical Officer, Malta Command, the casemate barracks were evacuated on July 11, 1906, and the portion of the regiment thus displaced was quartered in Fort Manoel Hutments. This regiment, in 1906, up to their departure from Malta in October, gave 44 cases, or, excluding six relapses, 38 cases. Of these, 40 occurred up to the end of July, and only four during August and September. It must be understood that the change to Manoel Hutments affected only about 250 men of the regiment, the rest of the regiment remaining in New Floriana Extension and Notre Dame Ravelin and Salvatore. The position of the Civil Hospital over the regimental offices and facing the casemate barracks has been remarked upon by Lieut.-Colonel Davies. We noticed the presence of numerous flies in Old Floriana Barracks, in spite of the fact that the barracks were kept in a very clean condition. This regiment, on the suggestion of the Commission, adopted the plan of having a fixed establishment told off permanently for sanitary work, and it was very well done. We had noted the presence of very many flies in the Civil Hospital, and we have little doubt that the Civil Hospital was the principal source of the flies in Old Floriana Barracks. The Civil Hospital contained many cases of Mediterranean Fever, and we think that the common fly may be regarded as a possible carrier of germs from milk and possibly from infected urine. Another noticeable feature of the surroundings of Floriana Barracks, old and new, was the large number of goats which were constantly crossing the regimental parade ground on the way to and from Valletta and Misida, and Valletta and Hamrun. Further, it was the custom to keep a herd of goats at the back of C Block, Floriana Extension, in a small ravine shaded by trees, all day and every day. There were always swarms of flies in this ravine, on and about the goats, and the place was used as a latrine by the goat-herds. This ravine was at a very short distance from the back of the barracks. Another herd of goats was kept in the ditch between Floriana Extension Barracks and the back of the new married quarters, Misida Bastion. This herd used to graze on the slope of the ditch at the back of the married quarters. We inspected many sheds in which goats were kept in Malta, and always noticed numbers of flies upon the goats. This was so marked as to force them on our attention as possible or rather probable carriers of infection.

We will now discuss in detail the cases of the West Kent Regiment during 1906 :—

1. Private P., F Company, was admitted to Valletta Hospital on October 5, 1905, and his blood was found to react on January 26, 1906. He had been in No. 3 Room, Old Floriana Barracks, for six months, and he was the first case which had occurred in his company for over six months. He had been in hospital in May, 1905, with sore throat. There is no evidence of contact. This man drank unboiled goats' milk and soda water, egg flip, and took porridge and milk outside barracks, in fact, was a fairly free milk drinker up to the time he got ill. His history makes it clear that he exposed himself freely to the risk of infection through milk.

2. Private L., G Company (see Hospital List No. 1). We think the disease was contracted in Citta Vecchia Hospital; if the disease was Mediterranean Fever from the beginning of his illness, it was possibly contracted through fly infection from the herd at the back of C Block, New Floriana. This man was not personally interviewed by us, as he was invalided before we reached Malta. We therefore know nothing about his drinking milk or not before he went to hospital; we do know, however, that he had been employed in a cook-house for two months before he got sick.

3. Private D., C Company, was admitted from No. 14 Room, Notre Dame Ravelin, on January 10, 1906, and was a relapse from December 27, 1905. He had been in Valletta Hospital—October 23 to November 13, 1905—with enteric fever, and again—November 27 to December 27, 1905—with Mediterranean Fever. He had been in Room 14 before both of these admissions, and had been company cook for three months before his enteric admission. This man states he never drank milk except in his tea. His occupation of cook makes the statement suspicious. No other case occurred in the room, and no other case had occurred for the previous six months. The disease may have been contracted in Valletta Hospital, where he had enteric, or in his work as a cook, when he had to handle milk and milk vessels.

4. Private O., C Company, was admitted from No. 6 Room, Notre Dame, on January 23, 1906. He had been in this room since he came out of hospital on November 27, 1905. He then was in from November 7 to November 27 with simple continued fever, and had exactly the same symptoms as he had in the present attack. On that occasion his blood did not react. He had three milk diets, and a pint of milk daily all the time he was in hospital. He states he never had plain milk outside hospital, but he has had tea frequently down town. We think this case is a probable relapse from last year. We can form no opinion as to how or where the disease was contracted.

5. Private B., F Company, was admitted from No. 4 Room, Old Floriana, on January 23, 1906. He had felt ill for three days. He was employed as company cook for two months before he got ill. He drank unboiled goats' milk daily while in that employment. Case No. 1, Private P., came from the same company, but had no contact with him, and came from another room. This, in our opinion, was an almost certain case of milk infection.

6. Private B., E Company, was sergeants' mess waiter. He was admitted January 31, 1906, and was a relapse case (October 12 to November 13, 1905). He lived in No. 3 Room, B Block, New Floriana Barracks. There was no case for four months from the room before his first admission, and none since during the year 1906. He was employed as waiter in the sergeants' mess before and after his first attack. States he never drank plain goats' milk, only took it in his tea. He had to handle goats' milk as a waiter. There is no evidence of contact.

7. Private S., D Company (relapse from October 13 to December 9, 1905). He came from No. 9 Room, Old Floriana, and had been in it since his discharge

from hospital in December. States he never drank goats' milk except in tea, in barracks, and down town. Private S.'s second admission was on January 31, 1906. Another man, Private B., was admitted from this room on April 29, 1906. The room had been disinfected in the meantime. Their beds were far apart on opposite sides of a long room. They were not companions. We can form no opinion how S. contracted his disease.

8. Private M., C Company, was the third case from this company during the year. He was admitted February 6, 1906, from Hut 5, Notre Dame. He had not been in the same room as either of the two previous cases in his company. This case was a relapse from November 26, 1905, to January 22, 1906. He was not personally interviewed by us, but we were informed by a man of his company with whom he "knocked about" that he drank goats' milk and egg flips frequently before his illness. This was a probable milk infection.

9. Sergeant A., G Company, the second case from the company, was admitted from C Block, New Floriana, where he had a small room to himself. This room looked into the goat-frequented ravine at the back of C Block. He had goats' milk in tea, and with porridge, at the sergeants' mess. There is no evidence of contact. We think this was either a milk infection or a fly infection from goats.

10. Private M. (see Hospital List No. 4). He came from Room 5, Old Floriana Barracks, and was only nine days in it before his admission to hospital.

11. Lance-corporal B., E Company, had been at Ghain Tuffieha for 15 days, then came to New Floriana, A2 room, where he remained for three days before his admission to hospital on March 4, 1906. He was not seen by us personally, but the colour-sergeant of his company informed us that he frequently drank goats' milk. He also had it in tea. He was the only case from Room A2 during the year. He contracted his disease either at Ghain Tuffieha or in Hut 8, Notre Dame, in which he had been before he went to Ghain Tuffieha. He ran the risk of infection by milk.

12. Private W., A Company, admitted March 6, 1906, from Room A1, New Floriana; had been at Ghain Tuffieha during the time Lance-corporal B. was there, but not in the same tent. W. was an officer's servant, whose master got Mediterranean Fever just after his return from Ghain Tuffieha. This man said he only drank milk in his tea, but he had tea in the mess, and had access to milk there. We think master and man got the disease at the same place, most probably in the officers' mess.

13. Private P., F Company (see Hospital List, Case 5).

14. Private P., B Company, was admitted from No. 5 Hut, Notre Dame, on March 15, 1906, having felt ill since February 20, 1906. He had been in Cottonera Hospital with gonorrhœa from November 19, 1905, to January 9, 1906. He was the first case from his company during the year, and the history of the case throws no light on its causation. He only had milk in tea, elsewhere than in Cottonera Hospital.

15. Private A, H Company, was admitted from Floriana, New, B4 room, on March 26, after feeling ill for three days. He had been at Ghain Tuffieha from February 21 to March 3. He was employed as company cook for six months before his illness, and we have positive evidence that he frequently drank goats' milk when so employed. There is no evidence of contact.

16. Private P., A Company, was employed as company cook in the same cook-house as Private A (see above). He was admitted on March 28, after feeling ill for two days. He came from Room 3A, New Floriana, but was admitted from Pembroke Camp. He was the first case from the room during the year, and, beside the fact that he worked in the cook-house with Private A., we can find no other evidence of contact. Stated he only took milk in his tea, a statement

which there is reason to believe is untrue. We consider these two cases as almost certainly due to goats' milk.

17. Private R., F Company (see Hospital List, Case 12).

18. Private L., B Company, was admitted on April 16, 1906, from a servant's room in the officers' mess. He was an officer's servant. He had no known contact. States he never drank milk except in his tea. He had access to it in the mess, and had to handle milk vessels. We consider him a milk infection.

19. Private S. H., B Company, Royal West Kent, was admitted April 17, 1906; had no previous illness in Malta, a married man, lived in 11, Floriana married quarters. No milk, except condensed milk, was used in his quarters, and he stated that he had never tasted goats' milk, even in his tea. His wife confirmed his statement. He had eaten no uncooked vegetables or fruit. None of the family have been, or are, ill. The quarters were in excellent sanitary condition. There is no history of contact. He was occasionally employed on latrine fatigues, and was so employed about eight weeks before he got ill. We could form no opinion as to the origin of his disease.

20. Private S., E Company, admitted April 21, 1906, from Room 6, Old Floriana Barracks. He had been in this room one week, before then he was in Room 3, B Block, New Floriana, where he slept in a bed opposite Private B. (see Case 6, above). He had been in hospital—February 1 to February 16, 1906—with simple continued fever, and said he never felt well after he came out. He was an officer's servant, and his master, Captain P., got ill soon after his servant. He used to drink milk in his master's quarters. We know that Private S. and Private B. had slept in opposite beds in the same room, before Private S. got ill, but no other relation could be made out between the cases. We think S. and his master are probable milk infections about the same time.

21. Private F., F Company, was admitted from Pembroke Camp on April 23, 1906. He had been in Cottonera Hospital with gonorrhœa—October 3 to December 6, 1905—and said he had never felt well since. From Cottonera Hospital he went to Room 4, Old Floriana Barracks, from December 6, 1905, to February 13, 1906; then to Corradino Military Prison to February 18; then Ghain Tuffieha, February 19 to March 3, 1906; then Old Floriana, Room 4, from March 3 to March 23; then to Pembroke Camp. Private B. (Case 5 above) came from Room 4 on January 23. He occupied the bed nearly opposite to Private F.'s bed. They were not companions, and had nothing to do with each other. F. frequently drank egg flips, which contained goats' milk. On March 31 he had a surfeit of this drink with a comrade who was "standing him treat."

22. Private B., D Company, was admitted from Room No. 9, Old Floriana, on April 29. He had been employed as company cook for two months before his admission, and used to taste unboiled goats' milk when so employed. Private S. (Case 7 above) came from the same room. They were the only two cases from the room during the year. We think this was a milk infection.

23. Private P., E Company, came from No. 6 Room, Old Floriana Barracks, and was admitted on May 1, 1906. There is no evidence of contact. Private P. was company cook, and states he used to drink goats' milk in the kitchen, where it was sterilised, but only after it was boiled. He had no previous illness in Malta, and felt perfectly well until three days before his admission. We think he was a milk infection.

24. Private B., H Company, was admitted from Room 2B, New Floriana, on May 2, 1906. He had been in this room since March 3, 1906. This was the only case from the room during the year. He was an officer's servant. States he only drank milk in his tea, but he had access to milk in the mess, where we think he contracted his disease.

25. Private R., C Company, was admitted from Pembroke Camp—where he had been from April 13 until date of admission—April 30, 1906. Before then he had been in No. 9, Notre Dame. Date of his admission is shown as May 4, but he was a transfer from Forrest on April 30, 1906. He had been company cook since December. He said he had drank milk in the cook-house, but once only, during the month before his admission. There was no other case from No. 9 Room, Notre Dame, during the year. We think this was a milk infection.

26. Corporal B., F Company, was admitted from No. 6, B Block, married quarters, on May 7, 1906. There were three other cases from this family, and all within a short interval of time:—1st. Rose B., aged 8 years, first felt ill on April 21, 1906. 2nd. Corporal B., first felt ill April 30. 3rd. Oliph B., who first felt ill about April 28. 4th. Edith Maud B., who had been ill since about May 9. There were three other members of the family living in the same quarters—Mrs. B., Mabel B., and Ernest B., none of whom, though apparently equally exposed to infection, contracted the disease. A son Walter had Mediterranean Fever in the summer of 1904, when living with his father's family, and none of the rest then contracted the disease. The family then lived in 13, Strada Magazzini. The son Walter never lived in their present quarters. They came to their present quarters in February, 1906. As the children sickened, they each slept in turn with the mother, while Mabel and Ernest slept in the bed with Oliph before she was known to be ill, and for some time afterwards. Corporal B. slept in Rose's bed, when Rose got ill and was put in her mother's bed. The members of the family who remained well had at least as close contact with the sick as the sick had with each other. The evidence about milk is somewhat conflicting. When the family came from Strada Magazzini to their present quarters in February, they changed from condensed milk to goats' milk, got from the herd which supplied the West Kent Regiment, and which a little later was known to contain infected goats. This evidence was got from Mrs. B. at the time a milk census of the married families was made, when as yet no members of the family were ill. Mrs. B. then stated that the family had been using goats' milk for two months. When Rose got ill, Mrs. B. stated goats' milk was used, but always boiled. When Corporal B. got ill he said goats' milk was only used for tea. When Oliph got ill, Mrs. B. modified her first statement, and said that goats' milk was only taken after Rose got ill. On one occasion, when one of us visited the house to get samples of blood, the children, during the mother's absence on a visit to the father in hospital, were found having tea, and were then using goats' milk. Another child from a quarter on the same verandah, who had only recently come out of hospital after an attack of Mediterranean Fever, was then playing with them. Contact cannot be denied, but: (1) None of the family got it when Walter had it in 13, Strada Magazzini; (2) Mrs. B. did not get it, though apparently more exposed to infection than any other member of the family, through sleeping with infected children; (3) Neither Mabel nor Ernest got the disease after having slept with Oliph before and after she got ill. The history illustrates the difficulty of obtaining accurate information about the use of milk. The obvious deduction, we think, where goats' milk comes into a house, whether stated to be used only for tea, or boiled, is to look on it with equal suspicion as though stated to have been used unboiled. We think the weight of evidence points to this outbreak having been due to the use of infected goats' milk.

27. Private B., F Company, was admitted on May 29 from Room 3, Old Floriana, where he had been for two months before his illness, after feeling ill for two days. Two other cases had come from this room during this year (Cases 13 and 17 above), but on both those occasions the room had been evacuated and lime-washed, etc. B.'s bed was on the opposite side of the room to those of the other two cases. The

history of this case throws no light on its causation. We believe it was possibly caused by infected flies. He had milk in his tea.

28. Private J., D Company, was company cook in Old Floriana cook-house for 14 months. He had no previous illness. He was admitted on May 22 from Room 10, Old Floriana Barracks, from which there had been no previous case during the year. He used to drink a pint of unboiled goats' milk daily. The herd which supplied this milk was found about this time to contain 11 infected goats.

29. Private K., G Company, came from 3c Room, New Floriana, and was admitted May 23, 1906. Says he only had milk in his tea. The history throws no light on the causation of the disease. C Block was much exposed to flies from herds of goats which sheltered at the back of the quarters. There is no evidence of contact, and no other case came from the room.

30. Private H. belonged to the same company as the last case, and came from the room underneath the one Private K. had come from. He was admitted two days later than Private K., *i.e.*, May 25, 1906. Private H., too, only had milk in his tea. We believe these two cases were probably fly infections from the goats which sheltered near the barracks.

31. Private H., A Company, was admitted on June 6; his blood reacted on the same day. He began to feel ill on June 2. He had been in 4 Room, A Block, New Floriana, for seven weeks before his admission. Before then he had done a short period of duty in the Military Police, and lived in 33 Hut, Tigne. He then did clerk's work in the regimental pay office, then ordinary duties, and at the time he went sick was doing a course of gymnasium. He only had milk in tea (and that condensed milk) since May 15. He never had food out of barracks. He had spring onions and cheese for supper frequently. There were two other cases from Hut No. 33, Tigne, during the year. This was the police hut, and the occupants were constantly changing. The two other cases were a soldier of the 2nd Essex Regiment, who was admitted on May 7, and a soldier of the 4th Rifle Brigade, who was admitted on May 21. These three men were in 33 Hut, Tigne, together, but they were not even acquainted with each other, and their beds were in different parts of the room. The room, No. 10, Old Floriana, from which Private H. was admitted to hospital had been occupied by Private J. (Case 28), but it is quite certain that Private H. did not contract his disease in No. 10 Room. He was feeling ill when he went to it, and was only in it two days. We can form no opinion as to the origin of this case, and do not think known contact can explain it.

32. Private I., G Company, was admitted from Ghain Tuffieha on June 6. He had been cook in the sergeants' mess since April 21, 1906. Said he only felt ill for three days before he went sick, but possibly was not feeling too well before then, as, having been a moderate drinker, he had become a teetotaler about three weeks. Before he went to Ghain Tuffieha he was employed as a company cook in Floriana Barracks, and he then drank goats' milk. He lived in Room 1, C Block, New Floriana, a room which looks into the goat-frequented ravine, which we have mentioned before. The cook-house at Ghain Tuffieha, when we visited it, was swarming with flies. Goats' milk was said not to be used in this cook-house. A large number of the ponies at Ghain Tuffieha were found to react to *Micrococcus melitensis*. The case was either a case of fly infection at Ghain Tuffieha or, as we think more probable, was contracted when he was cook at Floriana Barracks, and that the case, like many, is merely one of long latency.

33. Quartermaster-Sergeant C., D Company, was admitted on June 12, 1906, from 24, A Block, Married Quarters, Misida Bastion. His wife, an almost certain milk infection, had been admitted on May 7 with the same disease. Quartermaster-Sergeant C., and his wife, got ill about the same time. Mrs. C. drank goats' milk

freely, but said it was always boiled. Mr. C. said it was generally boiled, and he used it only for tea. Two boys, Stephen and John, never drank milk, and remained apparently quite well, though the blood of both boys gave a good positive reaction to *Micrococcus melitensis.* They were both strong, active lads, who on many occasions showed us round different places near these married quarters. They remained well all the season, and took hard exercise daily. We think the whole family were infected at the same time, and that the agent was infected goats' milk. There is no evidence of contact except among the members of the family. Husband and wife occupied one room, the boys another. The urines of both boys were examined on several occasions, with negative results.

34. Private S., B Company.
35. Private H. H., C Company.
36. Private K., C. Company.
37. Private H. W. G., C Company.

The four cases above are important from the point of view of place infection. Case 36 we think to be a probable case of milk infection. In the other three cases we have been unable to obtain any history of milk drinking. From the point of view of place infection they must all be considered together. Private S. had no previous illness in Malta. He first felt ill on June 11, with giddiness, and was admitted to hospital on June 14, 1906. His blood reacted on the same day. He was probably ill longer than he said, as, having been a great cigarette smoker, he had given it up entirely a fortnight before he went sick. He had never drunk goats' milk, and since May 15 only had condensed milk in his tea. There is nothing in his dietary or manner of life to suggest a clue to the probable source of his illness. He was admitted from Room 6, Notre Dame, but had been in it only since June 5, ten days before his admission, and six days before he felt ill. Before June 5 he had lived for over two months in Room No. 8, Old Floriana Barracks. He was the first case this year which occurred in Room 8, and it is quite clear that the case belongs to No. 8 Room rather than to Room 6, Notre Dame. It was noticed at this time how numerous the flies were in Floriana Barracks, and it was now that we visited the Civil Hospital, and found it very full of flies also. It was suggested that the windows of the hospital should be made fly-proof. The suggestion, though well received, had not materialised at the date when Old Floriana Barracks were evacuated. From S.'s history, it is seen that he sickened nine days, or less, after he left No. 8 Room, Old Floriana. Private H. H. (Case 35), the second case of the group, had been in No. 4 Room, Notre Dame, for more than two months until June 5, the same day on which Private S. left it. S.'s bed in Room 8 was No. 5, right. Private H. H.'s bed in Room 8 was No. 7 on the right. It is quite clear that S.'s illness was due to no contact with H. Whether H.'s illness had any connection with S., or Room 8, remains to be examined. H. H. came to Room 8 on the day S. left it. H. slept in a bed very close to the one S. had left, possibly the same bed. Neither bed nor room had been disinfected. S. was not ill when he left No. 8 Room. Here, apparently, are the elements of a pretty example of mediate contagion or place infection. Though S.'s case might explain H. H.'s and the other two cases, yet the converse does not hold good. Private H. H. came from No. 6 Room, Notre Dame, on June 5, to No. 8 Room, Old Floriana Barracks. His history, which follows, shows that he most probably had the disease when he came to No. 8 Room. He was admitted into hospital on June 15, and his blood reacted on the same day. If he contracted his disease in Room 8, *i.e.*, if the same cause operated in H.'s case as in S.'s, then H.'s case must be one of ten days' incubation exactly, at the extreme limit; but H. manifested almost the only symptom of his illness on June 11. Therefore the incubation period is reduced to seven days, *i.e.*, from June 5 to June 11. H. began to suffer from pains in the

knees on June 11, and had no other symptom, except rise of temperature, through the whole course of his attack. He never felt sick or lost his appetite. For a fortnight at the beginning of May he was on barrack hospital treatment for exactly the same kind of pains in his knees as caused him to go sick in June. At that time his temperature was not taken. He then was in No. 6, Notre Dame, and had been for two months. He had been an officer's servant until May 2, and, his master going on leave, he then returned to ordinary duty. He had a relapse in September. Thinking he might have been an ambulatory case, and excreting *Micrococcus melitensis* in his urine, we had it examined on several occasions, always with negative results. The history of this case makes it clear that Private H. H., when he came to Room 8, Old Floriana, was already the victim of a mild attack of Mediterranean Fever, and consequently had no connection with Private S. or Room 8.

The next case, Private K., No. 36, had been in Cottonera Hospital from May 30, to June 11, 1906, suffering from synovitis. He was admitted on that occasion from Room No. 8, Notre Dame, and therefore, so far as place is concerned, had as yet no connection with either H. or S. He had been in No. 8, Notre Dame, for two months. He came to No. 8 Room, Old Floriana, on the evening of June 11, and occupied the bed next to H.'s. He felt quite well on discharge from Cottonera, and remained so until June 18, when he had headache which continued, and he was admitted to hospital on June 21, and on the same day his blood reacted. If he got ill in No. 8, Old Floriana, he must have got his disease between June 11 and 17, on which date Room 8 was evacuated for disinfection, and all the occupants were put in tents on the roof. He must, therefore, have contracted the disease in six days, quite possible, but in his case highly improbable. His blood reacted on June 21, and the case was a mild one. Cases caused by direct inoculation, as a rule, are severe, and unless this was one, his blood would hardly have reacted within eight days of his getting the poison, and he would not have manifested symptoms within six days. The synovitis, too, from which he suffered in May, is suggestive. Though the possibility of direct inoculation in Room 8, Old Floriana, must be allowed, the history of the case makes it more than probable that Private K. contracted his disease elsewhere. We have but little evidence on which to base an opinion as to where he did contract his disease, but on asking him if he ever drank goats' milk in any form, he stoutly denied ever having done so, forgetting that he had already told us, when we examined all the men in the company as to whether they took milk, that he frequently drank egg flips, one of the ingredients of which was unboiled goats' milk; he then also stated that he drank rum and milk, a fairly common drink among soldiers in Malta.

Case No. 37, that of Private W. J. H., brother of H. H. (Case 35), must now be considered. Private W. J. H. had been employed for seven months in the Military Police, during which time he lived in 1A Block, New Floriana. Fourteen days before his admission to hospital he became an officer's servant, and on June 12 he went to live in No. 8 Room, Old Floriana. He left this room and went into a tent on the roof, as did the other occupants on June 17. He was therefore only exposed to the presumed malign influence of Room 8 for five days, from June 12 to 17. His blood, in common with those of 23 other men, contacts of the previous cases, was examined, and being found to react, and having a slight rise in temperature, he was sent to hospital on June 22 for Mediterranean Fever. In hospital he never felt ill, and did not believe there was anything the matter with him. None of the bloods of the other contacts reacted. If W. J. H. contracted his disease in No. 8 Room, he must have done so between June 12 and June 17, *i.e.*, in four days. His blood, taken on June 19, was reported to react, and again on the 23rd. As he never felt ill, it is difficult to decide when he got his disease. From June 12 to 19

(date of his first reaction) is only seven days, but all which can be granted if he contracted his disease in No. 8, Old Floriana.

These four cases have been reviewed at great length because they seemed at first to furnish a good example of contact or place infection, but careful examination of each case seems to negative that view. It is certain that H. H. did not contract his disease in Room 8, and the evidence is almost equally strong against Private K. having got ill there. Thus an apparently strong case for contact becomes a decidedly weak one. We conclude that Private S. contracted his disease when living in No. 8 Room, Old Floriana, and think that flies are a quite probable explanation of his case. We think Private H. H. contracted his disease while living in Room 4, Notre Dame, before the beginning of May, when he was an officer's servant. He denied drinking milk or eating uncooked vegetables. His occupation is suggestive. Private K. contracted his disease while living in Room No. 8, Notre Dame, and he is a possible case of milk infection by egg flips and rum and milk. Private W. J. H. was a pal of Private K., and used to knock about with him. He may have contracted his disease in the same place as Private K. Information from the colour-sergeant of his company was obtained to the effect that these three men used to frequent a public-house, paying attention to the same barmaid, and where they had egg flips. It is therefore possible that this was a common source of infection.

38. Private J., C Company, was admitted on June 25, 1906. His blood reacted next day. He came from No. 7 Room, Old Floriana Barracks, where he had lived since June 16. Up to then he had been caretaker and sole occupant of Vittoriosa Barracks from May 5. Before then he was in No. 15 Room, Notre Dame. He first felt ill with headache and faintness on June 16, when shifting his kit from Vittoriosa Barracks. He says he had been perfectly well until then. Neither his manner of life nor his diet suggest any clue to the source of his illness. At Vittoriosa he lived in the guard-room, a dark and mouldy, ill-ventilated building. Most of the ventilating shafts to the sewers are broken just above the ground level, and at times emit foul odours. He had his meals with a detachment of the 4th Rifle Brigade in Verdalla Barracks. There is no evidence of contact or of his ever having drunk goats' milk.

39. Corporal T., F Company, a relapse from September 4 to November 27, 1905. He was re-admitted on June 27 from New Floriana Barracks, where he had been for three days. Before then he had been in a tent on the roof of Old Floriana Barracks since May 5. His urine was examined to see if he was excreting *Micrococcus melitensis*. Result negative. He states he only drank milk in his tea. and that his first attack was contracted at Pembroke Camp, where he was in charge of the camp latrines.

40. Private S., A Company, was admitted June 30 from 2B Block, New Floriana, where he had been for three weeks. Before then he had been in Room 4, Old Floriana. He had had slight fever and pains at the beginning of April. These pains got worse through bathing, and he got headache about June 24. He had been in Room 4, Old Floriana, for over six weeks, and he probably was ill since April. He was an officer's servant, and had goats' milk in tea at the mess; he says he never drank it plain. We think he contracted his disease in the officer's mess before goats' milk was stopped there.

41. Lance-Corporal R., A Company, was admitted from No. 9 Room, Old Floriana, on July 9. He had been in this room for two months. He was admitted for gonorrhœa, and his disease was changed to Mediterranean Fever on August 3, 1906. He contracted gonorrhœa on June 30. He used to drink goats' milk up to the middle of June. His first symptoms of illness began on July 16, with double sciatic pains. These pains persisting, and he having fever, his blood was examined,

and found to react on August 2, 1906. There was no history of contact. He either contracted his disease where he got gonorrhœa or else when he drank milk, which he did freely until the middle of June. He also drank egg flips frequently.

42. Private B., F Company, first fell ill on August 6, 1906, with headache, backache, and giddiness. He was admitted on August 7, and his blood reacted on the same date. He had been in No. 17 Hut, Manoel, since July 11, 1906. Before then he was in a small room on the ground floor of Block B, New Floriana Barracks. He had this room to himself, and was in it since the beginning of May. In June (June 28 to July 2, 1906) he was in Cottonera Hospital, with inflammation of connective tissue, the result of scratching his arms, which had been severely bitten by sand flies. He then had slight fever, but felt perfectly fit during the interval between his discharge and readmission. He never drank goats' milk, and there is no evidence of contact. There had been no other case in any room in which he lived during the year. He used to have uncooked tomatoes for his supper frequently. He visited a brothel July 19, 1906. No venereal disease resulted.

43. Private H., September 1, 1906, relapse. (See Case 35.)

44. Private S., F Company, was admitted from Salvatore Counter-guard where he had been for the past eight months. He was admitted on September 12. The man was a signaller. The history of the case throws no light on its causation. This was the only case from the counter-guard during the year. The men in the counter-guard were living quite apart from the rest of the regiment.

The distribution by companies was as follows:—

A Company	...	6	cases.
B ,,	...	4	,,
C ,,	...	9	,, (including four relapses).
D ,,	...	4	,,
E ,,	...	4	,,
F ,,	...	10	cases (including one relapse), one married man and one man from Salvatore Counter-guard.
G ,,	...	5	cases.
H ,,	...	2	,,

The spot map shows the barracks from which each case came.

We consider that 28 of the above cases were most probably milk infections, while all, with a few exceptions, are possible milk infections.

By barracks the distribution was:—

Old Floriana Barracks	...	14	cases.
New Floriana ,,	...	14	,,
Notre Dame ...	...	8	,,
Salvatore Counter-guard	...	1	,,
Other places ...	...	7	,,

A careful analysis of the cases occurring in the several companies and in the various parts of barracks was made, and we were unable to discover any particular persistence of the disease in any company or in any particular part of the barracks.

The most striking fact about the history of this regiment is that in the first six months of the year forty cases occurred, whereas, for the remaining four months of the battalion's stay in Malta, the months which usually are marked by special prevalence of Mediterranean Fever, there were only four admissions. Of these, one was a relapse, and the second was that of a case in which there is a definite history of goats' milk drinking. The first six months was the period marked by the use of goats' milk; the second represents the period in which condensed milk was in use.

Series 2.—The Cases in the Royal Army Medical Corps.

1. Private H. was admitted to Valletta Hospital for Mediterranean Fever on January 12, 1906. He had been employed as a nursing orderly on night duty in the Mediterranean Fever wards. His previous hospital entries are simple continued fever September 15 to September 22, 1905, Valletta Hospital; he then had four milk diets and 15 pints of extra milk. Again, simple continued fever October 9 to October 17, 1905, Valletta Hospital, where he had six milk diets and 11 pints of extra milk. Again, caries of dentine November 23 to November 29, 1905, Valletta Hospital, when he had five milk diets and 7 pints extra milk. Admitted for Mediterranean Fever January 12, 1906, and had been feeling unwell since January 1. This case was certainly contracted in the hospital either as a patient or when doing nursing duties. It seems to be a 1905 case, and not having examined the man personally, we think that the information available makes it possible that the case was due to hospital milk.

2. Lance-Corporal B.—Admitted January 17, 1906, for Mediterranean Fever. He was employed working the steam disinfector at Cottonera Hospital, and is believed to have contracted the disease through handling soiled bed linen. We know nothing about his drinking milk beyond the fact that goats' milk was then in use at the hospital. From what we know, infected clothing seems the most probable source of his illness.

3. Private Y.—Admitted January 22, 1906, for Mediterranean Fever. He had been detachment mess orderly for the Royal Army Medical Corps, employed at Cottonera Hospital, for three months before he got ill. He is noted as being habitually careless. There is no evidence of contact with Mediterranean Fever patients. Goats' milk was in use in detachment mess. In the absence of other information, he is a possible case of milk infection.

4. Corporal W.—Admitted February 15, 1906. First felt ill, February 1, 1906. Employed at Forrest Hospital since December 8, 1905, in charge of disinfection duties. Is supposed to have contracted his disease through handling infected clothing. Nothing known about his drinking milk. Goats' milk was then used at Forrest Hospital.

5. Private P.—Admitted February 15, 1906. Has had pains since January 15, but has never felt really well since attack of simple continued fever in July and August, 1905. He had some teeth extracted in December last, and was then a patient in hospital from November 28 to December 3, 1905, and had two days' plain milk diet when teeth were extracted, otherwise states he only had milk in tea. He was employed at Valletta as nursing orderly in Mediterranean Fever wards, and did night duty, and had to handle vessels containing stools and urine of Mediterranean Fever patients. Said he was always very careful about personal disinfection. This man was evidently ill since January 1, and may possibly be a milk infection. The case was contracted in Valletta Hospital.

6. Private L.—Admitted February 28, 1906, after feeling ill for three days. Had simple continued fever in August, 1905. Was employed as nursing orderly in Mediterranean Fever ward at Valletta. This man states that he frequently drank goats' milk with soda water. He used to get it at the canteen. Does not know whether boiled or not. This man is a quite possible milk infection.

7. Lance-Corporal P.—Admitted March 12. Had been employed in the Mediterranean Fever Commission laboratory when experimental work was being tried there with infected dust. He almost certainly was a case of laboratory infection. He drank goats' milk in tea only. He thinks infected dust was the cause of his illness.

8. Private B.—Admitted April 1. Was employed in enteric and Mediterranean Fever wards, Valletta. Had no previous admissions in Malta. Went for duty to Imtarfa on March 17, and first felt ill on March 29. Had much handling of bedding and bed-pans and urinals of Mediterranean Fever cases; was in the habit of drinking goats' milk unboiled freely at the house of a civilian friend, an almost daily habit until the time of illness. This is a very possible case of milk infection.

9. Private C.—Admitted April 3, 1906, had no previous admissions. Employed on general duty in Cottonera Hospital. Had little or no direct contact with Mediterranean Fever cases. This man said that he frequently took both boiled and unboiled goats' milk, and that he took it in large quantities. He also informed us that many Royal Army Medical Corps men did the same. He attributed his illness to a wound of the hand caused by a splinter when scrubbing the floor in No. 5 Ward, Cottonera Hospital. He often took tea in Valletta tea shops. This is a quite possible case of milk infection.

10. Corporal F.—Admitted April 8, 1906, after feeling ill for four days. Employed as store-keeper, and had much handling of infected linen, etc. Was seldom or never in the Mediterranean Fever wards. This man states that he never drank goats' milk even in tea. Milk seems out of the question in this case.

11. Corporal B.—Admitted May 1, 1906, after feeling ill for three weeks. Has no previous hospital entries. Was employed at Forrest Hospital as assistant ward master, pack store keeper, and in charge of bedding. He had to steep the linen of patients in carbolic lotion before its removal to Cottonera Hospital for steam disinfection, but had not much of that class of work at Forrest Hospital, and little or no contact with Mediterranean Fever cases. Drank soda water and goats' milk daily. This man's wife got Mediterranean Fever shortly after her husband's admission. They lived in quarters (the caretaker's house, Spinola Battery), some distance from Forrest Hospital. Mrs. B. states that she, too, drank soda water and goats' milk, but that she always boiled the milk for her husband and herself. There are excellent grounds for believing that this house was not very carefully managed, and though her statement may be in the main true, as she is careless in other matters she is not likely to have been careful in the matter of milk boiling. These cases are both possible cases of milk infection; indeed, we believe milk to be the most likely source.

12. Private M.—Admitted for Mediterranean Fever on May 9. He had been employed in the general duty section at Valletta Hospital, and just before his admission was employed window cleaning in the long ward, Valletta Hospital, at the time a general disinfection of this ward took place. He attributes his illness to this cause. The medical history of the case, however, suggests that this cause had nothing to do with the case, and it is quite likely that he contracted his disease in 1905. He had offered himself for protective inoculation, and on examining his blood before this was done it was found to give a positive reaction to *Micrococcus melitensis*. This was on April 25, 1906. In consequence of the reaction he was not inoculated. His medical history is as follows: Sprain (right ankle), December 20 to December 23, 1905, no definite cause; sprain (right knee), February 21 to

February 26, 1906. Rheumatism, March 24 to March 27, 1906; rheumatism, March 28 to March 29, 1906. Colic, April 28 to April 30, 1906. He says he only had goats' milk in tea, and also in hospital as a diet when he had colic and on the previous occasions. He had no direct contact with patients, but had to clean the seats of No. 37 latrine and oil the urinal. It is difficult to believe that the dusting of the windows in the long ward in April had anything to say to this man's illness. The source of infection is not known, but it is a possible milk infection.

13. Private B.—Admitted on May 13, after three days' illness, and had no previous illness in Malta. Has been lunatic attendant at Cottonera Hospital since arrival in Malta (October 3, 1904). He had cut the hair of a few patients who had Mediterranean Fever, the last time he did so being April 25, 1906. He slept in a bunk by himself. Stated he only had goats' milk in his tea, and about twice a month with porridge; the last time he had porridge and milk was about April 21. He thinks he contracted his disease through cutting the hair of Mediterranean Fever patients. This is a possible milk infection.

14. Corporal G.—Admitted May 13, 1906, after feeling really ill since the middle of April, but had no previous admission. He was clerk in the office at Cottonera Hospital. He never went into the Mediterranean Fever wards, but used to send off the blood pipettes containing the blood of cases for examination. He stated that sometimes a tube was open, and that blood may have got on his hands. He slept in a bunk by himself, and had his meals at the sergeants' mess, where each man puts the milk into his own tea, *i.e.*, milk and tea not in bulk. He stated that he had never taken goats' milk neat. He used to have tea and coffee in a tea-house, Valletta, occasionally. Goats' milk is as probable a source as any other in this case.

15. Private S.—Admitted May 25, 1906, after feeling ill for five days. Employed at Valletta Hospital in general duty section. His principal duties were spraying the rooms and beds of patients who had been removed to hospital with Mediterranean Fever, and superintending the milking of the goats at Valetta Hospital. M. (case 12) had slept in the bed next to his bed, but not for a fortnight before M. went sick. Interval between April 26 to May 25. Says he only had goats' milk in tea in hospital, but used to have egg flips freely on Saturday nights; last occasion May 12, 1906. These egg flips were got at the Round House, Strada Reale, and contained goats' milk. This is a possible case of infection through milk.

16. Private J.—Admitted June 19, 1906. Employed as sergeants' mess waiter at Valletta Hospital, and had been ill since June 11, 1906. He had milk in tea until May 21, and drank unboiled goats' milk about a fortnight before that date. He had access to milk in the sergeants' mess. There is no history of contact, and no previous illness in Malta.

17. Lance-Corporal J.—Admitted September 2, but ill since August 1, or probably longer. He worked all the season in the Commission laboratory, and had to handle many infected animals. He had been twice inoculated against Mediterranean Fever. Milk in tea only. Is an almost certain laboratory infection.

18. Private B.—Had been in Gozo for two years and nine months, before which period he had had simple continued fever for 22 days in Valletta Hospital (October 5 to October 27, 1903), on which occasion he was ill for three weeks before he went sick. He returned from Gozo on March 19, 1906. He was twice inoculated against Mediterranean Fever this year, on April 26 and on May 10, 1906. He was a patient in Valletta Hospital from May 30 to June 6 with dyspepsia, and again with debility September 3 to September 15, and on September 16 disease was changed to Mediterranean Fever. He had been feeling ill since May 15 with pains in different parts of his body and limbs. His duties after his return from Gozo were four days' gate duty, then washing floors and windows and woodwork of 20A Ward after it had been disinfected and colourwashed in April, after which he was taking bed cots

to pieces, and oiling and cleaning them. This work took about 14 days. After this, did 28 days' night duty in Mediterranean Fever ward. Next had an admission to hospital as above. When discharged had 14 days on gate duty; after that did general duty fatigues up to the time he went sick, on account of increasing pains. This man states that he only drank milk in his tea. The beginning of his illness is quite uncertain. He may possibly have had a mild attack of Malta Fever before he went to Gozo, and he seems to have got his present attack about May this year. It is a possible milk case.

From the histories of the above cases it is seen that their employments were as follows:—

Five men were employed as nurses of Mediterranean Fever patients. Two were in charge of the steam disinfector for the disinfection of linen, bedding, clothing, etc., of Mediterranean Fever patients. One was the detachment mess orderly at Valletta Hospital, and had no contact with Mediterranean Fever cases. Two were attendants in the laboratory of the Mediterranean Fever Commission. Three men were employed in the general duty section of the Royal Army Medical Corps, and had very little to do with Mediterranean Fever cases directly or indirectly. One man was hospital store-keeper, and had to handle infected linen. One was assistant ward master at Forrest Hospital; he had little to do with Mediterranean Fever cases. One was a lunatic attendant (no contact). One was a clerk in the office at Cottonera Hospital (no contact). One man was sergeants' mess waiter (no contact).

Of the whole series, in three cases only is it possible to exclude goats' milk as a possible factor in the causation of the disease. Six cases in our opinion were most probably due to milk infection.

Series 3.—Hospital Cases.

Of cases which we think were contracted in hospital, other than men of the Royal Army Medical Corps, there are 23, or 14·5 per cent. of all the cases to the end of November. None of these presumed hospital infections took place later than June 11, and the case diagnosed on that date was that of Quartermaster-Sergeant W., Royal Engineers, who had been in Valletta Hospital since February 27, with enteric fever. He was a married man and lived in the married quarters, St. George's Barracks. His wife did not contract the disease. He had no contact with Mediterranean Fever patients. We think his illness was most probably due to milk infection while a patient in hospital. The last case before Quartermaster-Sergeant W.'s was admitted on May 30. It is thus evident that all the possible hospital infections during the year occurred within a period of 15 days after the use of goats' milk was stopped in the military hospitals.

The history of the remaining 22 cases is given below :—

1. Private L., Royal West Kent Regiment, was invalided before we arrived in Malta. He was admitted from Room 4, Block C, New Floriana Barracks, the only case during the year from the room, on November 11, 1905, to Cottonera Hospital, with simple continued fever, and was transferred to Citta Vecchia on December 24, 1905. He was on milk at Cottonera from November 14 to the end of the month, and at Citta Vecchia he had milk from January 2. His blood reacted to the *Micrococcus melitensis* on January 14, 21 days after his transfer from Cottonera. He seems to have contracted his disease at Citta Vecchia, and is a possible case of milk infection.

2. Gunner P. was admitted into hospital on January 8, 1906, from Hut 30, Tigne, from which hut there were no other cases during the year. He was admitted with gonorrhœa. His disease was changed to Mediterranean Fever on January 30, 1906, and his blood reacted on January 31. He had been feeling ill for a week. He had two days on milk on his admission. He stated that he often drank soda and milk at different houses in Sliema and Valletta.

3. Bombardier S., Royal Garrison Artillery, had been in Tigne, Block A, Room 1, and from there was admitted to Valletta Hospital, with psoriasis, on October 17 to December 6, 1905. From Valletta he was transferred to Citta Vecchia Sanatorium from December 7 to February 8, 1906. He was diagnosed as Mediterranean Fever on February 10, 1906, after feeling ill for four days. His blood reacted on February 10. This was his first illness in Malta. The disease was contracted at Citta Vecchia, where he had milk (extra) every day from his admission. He had possible contact with convalescent patients in Citta Vecchia, but no direct relations with them.

4. Private M., 1st Royal West Kent. The history is curious. Private M. was in Cottonera Hospital from August 29 to November 28, 1905, with gonorrhœa. On discharge from hospital, he went to No. 5 Hut, Notre Dame, where he lived for five days, and then embarked for England, time expired, on December 3, 1905. He remained in England, perfectly well, until February 10, 1906, and then, having rejoined, embarked for Malta, where he arrived on February 19, 1906. When marching up to barracks from the ship, he got drenched with rain (February 19, 1906, was a day of heavy rainfall—1″·943—for Malta), and next day he felt stiff and ill, with pain in the left shoulder and a feeling of malaise. This pain got worse, and on February 27 he was admitted to Valletta Hospital, where he was found to have fever. His blood reacted on March 4, 13 days after he reached Malta. The time is long enough for a man to get Malta Fever, but this man was perfectly certain that on February 20 he had all the symptoms for which he was admitted to hospital on February 27. He had a first-class memory, and told all the dates without pause, which were subsequently verified by reference to official documents. Where or when did he contract his disease? We think he contracted it in Cottonera Hospital before his departure for England, otherwise he began to manifest the symptoms of it on the day after his return to Malta.

5. Private P., 1st Royal West Kent, was admitted to Valletta Hospital, after feeling ill for five days, on March 12, 1906. He had been in Room 33, Old Floriana Barracks, for 89 days, before which he had been in Valletta Hospital with gonorrhœa, and had had milk during that admission. He is a probable hospital case, otherwise he may have contracted his disease when he got his gonorrhœa.

6. Gunner B. This man was stationed in Fort Ricasoli since his arrival in Malta. He had been in Room 2 for four months, and was the only case from the room this year. He had been in Cottonera Hospital from February 15 to February 23, 1906, with an abscess in the hand and, on discharge, returned to Ricasoli, which he hardly ever left in the interval between discharge and

readmission, as he "felt weak." He got leg pains and headache on March 16, and was admitted with Mediterranean Fever on March 21, and his blood reacted on March 25. This man used to frequent both public-houses and tea-shops before his first admission to Cottonera. It is probable that he contracted his disease in Cottonera Hospital, or in some of his Valletta haunts. He had several days' milk diet in Cottonera on his first admission, and he also used to have tea frequently in Valletta tea-shops.

7. Trumpeter S., 100th Company, Royal Garrison Artillery, was admitted into hospital, March 28, 1906, and was found to be suffering from Mediterranean Fever. Blood reacted April 2, 1906. He had been feeling ill, *i.e.*, tired and had headache frequently, and pains in arms and legs, and poor appetite, for about two months before his admission, that is to say, he felt ill from the first week in February. He had been in Cottonera Hospital—November 16 to December 5, 1905—with gonorrhœa, and had had milk in hospital. He said he had never had food out of barracks, and then only barrack rations and tea (condensed milk). He ate no uncooked vegetables or fruit. He spent a few days in No. 11 Room, Ricasoli, before his admission, from which room Bombardier C. was admitted for Mediterranean Fever on March 1, 1906. Trumpeter S. obviously did not contract his disease in No. 11 Room, as he had been feeling ill a long time before he went into it. If he contracted his disease in Ricasoli it was in Room No. 6, where he lived from the time of his discharge from Cottonera until his readmission for Mediterranean Fever.

It may be remarked here that five cases out of eight, admitted for Mediterranean Fever in 1906, had all been in Cottonera Hospital at or about the same time, suffering from other complaints, and were readmitted with fever within two months of their discharge, *i.e.*, the following cases:—

Gunner R.—Cottonera Hospital, for soft chancre, September 26 to December 9, 1905, during which time he had some fever, but his blood did not react. He was readmitted with Mediterranean Fever January 21, 1906. Interval between discharge and readmission, 43 days.

Gunner L.—Cottonera Hospital, for inflammation of lymph glands, October 22 to November 20, 1905, was then transferred to Citta Vecchia Sanatorium from November 21 to December 19, 1905, and was readmitted for Mediterranean Fever January 26, 1906. Interval between discharge and readmission, 37 days.

Gunner D.—Cottonera Hospital, for soft chancre, October 31 to November 28, 1905, and was readmitted January 17, 1906, with Mediterranean Fever. Interval between discharge and readmission, 50 days.

Gunner K.—Cottonera Hospital, for gonorrhœa, November 21 to December 5, 1905, and was readmitted for gonorrhœa January 15, 1906, and his blood reacted to *Micrococcus melitensis* January 18, 1906. Interval, 41 days.

Trumpeter S.—Cottonera Hospital, for gonorrhœa, from November 16 to December 5, 1905, felt unwell since the first week in January. Interval between time he was discharged from hospital and time he began to feel ill, about 26 days.

The sequence of the cases is suggestive of a possible hospital source, but these cases have not been included in the hospital list, as we have not sufficient facts on which to base a definite opinion.

8. Gunner N., 96th Company, Royal Garrison Artillery, had been in St. James' Cavalier Barracks, Room No. 4, for three months. No other case from this room. He had been in Valletta Hospital with catarrhal jaundice from February 17 to March 5, 1906, during which time he was on milk diet. He began to feel ill about March 22, and was readmitted to Valletta Hospital on March 28, and his blood reacted on April 6, 1906. There is no evidence of contact. The disease was most probably contracted in Valletta Hospital.

9. Private R., 4th Rifle Brigade, had been in St. George's Barracks, Room No. 6, B Block, since arrival in Malta. His medical history is as follows: Myopia (Forrest Hospital), January 26 to February 5, 1906. Myopia (Valletta Hospital), February 5 to March 2, 1906. Readmitted (Valletta Hospital), for myopia on April 4, 1906, and about 18th began to feel ill, and blood reacted on April 23, 1906. He used to drink goats' milk when band cook, but he ceased to be employed as a cook on January 26, 1906. He had milk in Forrest Hospital from January 26 to February 5, 1906. The disease was probably contracted at Forrest Hospital.

10. Lance-Sergeant C., 2nd Essex, was at Ghain Tuffieha, August, September, and October, 1905, then for the next three weeks at Imtarfa, and for the next three weeks at Pembroke Camp, then at Mellieha Camp, and there reported sick with gonorrhœa, and was tranferred to Valletta Hospital December 21, 1905, to March 17, 1906. He was then transferred to Imtarfa to attend hospital. He was discharged to duty on March 20, 1906. He was readmitted to Imtarfa on April 6 with fever, and was transferred to Valletta on April 20, 1906. A week before he left Valletta, during his first admission, he had headache, and felt out of sorts. He was on milk for a month after his admission, and his disease was most probably contracted in Valletta Hospital. He was in contact with Mediterranean Fever cases in the wards, but had no direct relation with the cases. He had nothing to do with the patients.

11. Gunner S.—Admitted from a tent in Fort Ricasoli. Medical history: gonorrhœa February 1 to April 7, 1906, Cottonera Hospital; transferred to Imtarfa Hospital April 7, 1906, where he remained until he was sent back to Valletta Hospital on April 20, 1906. He had fever all the time he was in Imtarfa Hospital. He stated that he had been in bed with fever at Cottonera Hospital for a few days, about March 3, 1906. He had milk at Cottonera from February 2 to 4, from February 7 to 12, and from February 21 to 24. He was feeling out of sorts about a fortnight before he left Cottonera Hospital. Only had contact by meeting convalescent cases in the library at Cottonera; no known contact outside.

12. Private R., Royal West Kent, from Room No. 3, Old Floriana Barracks. Medical History: inflammation of ear, Valletta Hospital, March 15 to March 27, 1906; gonorrhœa, March 29 to April 9, 1906. He first felt ill on April 14, and was admitted April 16, and his blood reacted on April 18. He was in Room No. 3, Old Floriana Barracks, for five days only when he felt ill. He was on milk in Cottonera Hospital from March 30 to April 2, 1906. He owned to drinking goats' milk at Pembroke Camp on the day before his admission. He denied having ever been in a brothel, but had had gonorrhœa. Private P. (Case 5) came from Room No. 3, Floriana (see above). He was admitted March 12, 1906, at which time R. was in hospital; R. almost certainly contracted his disease at Cottonera Hospital, and is a possible milk infection, or he contracted his disease at the same time as his gonorrhœa.

13. Gunner S.—Was admitted from Hut No. 19, Tigne, but up to four days before he was in Hut No. 31, and there was no other case from either during the year. He had been in Valletta Hospital with psoriasis from April 23 to March 16, 1906, and was transferred to Citta Vecchia with the same disease from March 17 to April 2, 1906. From day of his discharge, he did officers' mess fatigues. He felt ill on April 13, 1906, and was admitted with Mediterranean Fever on April 14, 1906. There is no evidence of contact. He was on ordinary diet and one pint of milk at Valletta, and on the same at Citta Vecchia, where his disease was certainly contracted.

14. Gunner K.—Gonorrhœa, from March 4 to March 20, 1906, in Valletta Hospital, and was transferred with the same disease to Cottonera Hospital on March 21, and he began to feel ill on April 9. Disease was changed to Mediterranean Fever on April 16. He had milk diet and porridge and milk up to date of

transfer. He came originally from Room No. 18, Upper St. Elmo. There is no evidence of contact. Disease was contracted in Valletta Hospital.

15. Lance-Corporal B., Army Service Corps, in Valletta Hospital, for soft chancre, January 22 to March 16, 1906, then discharged to attend hospital. He was not allowed out of barracks (Old Laboratory) except to attend hospital. When attending on April 11, 1906, he began to feel out of sorts, and on April 25, 1906, was found to have a temperature, and was then admitted. His blood reacted on April 27. At the time he left hospital, he was on ordinary diet and a pint of milk. He had no contact in barracks and no direct contact in 20B Ward, Valletta. This is a hospital case.

16. Gunner B., married man, wife and four children all well, and none of their bloods reacted. He came from No. 5, Married Quarters, Vicolo Tigne. The medical history is a curious one. Simple continued fever from November 1 to November 5, 1902. Simple continued fever from October 1 to October 8, 1905. Simple continued fever from October 14 to November 3, 1905 (Valletta Hospital). Gout from January 25 to February 5, 1906 (Valletta Hospital). Gout from March 17 to April 16, 1906. He developed Mediterranean Fever at Citta Vecchia on May 4, 1906. His blood reacted May 6, 1906. He was not in contact with Mediterranean Fever cases either at home or in hospital. Condensed milk only is used in his home. He had milk both at Valletta and Citta Vecchia. This case probably dates from October 14, 1905, and is most likely a hospital infection, and milk as the agent cannot be excluded.

17. Gunner M.—Arrived in Malta November 10, 1905, and had been stationed in Valletta since. Medical history: Cottonera Hospital, gonorrhœa from December 2 to December 15, 1905. Valletta, balanitis from January 15 to January 19, 1906. Gastritis and gonorrhœa from February 6 to March 21, 1906, in Cottonera Hospital. Gonorrhœa from March 22 to April 10, 1906, and operation for varicocele. Was admitted from a tent in Upper St. Elmo Barracks on May 6, 1906, after feeling ill for a fortnight with headache and sore throat. He had not left barracks, except on duty, since last discharge from Cottonera Hospital. He was on milk during his last admission to Cottonera Hospital. There is no evidence of contact. This man contracted his disease in Cottonera Hospital, and is a possible milk infection. Gonorrhœa was not contracted in Malta.

18. Private M., 4th Rifle Brigade.—Was in St. George's Barracks, but has been almost constantly in hospital since his arrival in Malta. He got a blow on the left knee when doing transport work, which resulted in synovitis. From December 30, 1905, to January 6, 1906, he was in Forrest Hospital with synovitis. He was in Valletta Hospital from February 2 to March 26, 1906, with synovitis, and was transferred to Citta Vecchia Sanatorium from March 27 to May 8, 1906, and on May 9 Mediterranean Fever was diagnosed. This man probably got his disease at Citta Vecchia, where he was on milk for over a fortnight before he began to feel ill. There is no evidence of contact either in barracks or hospital.

19. Gunner B. was quartered in St. James' Cavalier until February, then came to Upper St. Elmo. He had the following medical history: gonorrhœa, February 21 to March 14, 1906, Valletta Hospital; tonsilitis, March 25 to March 27, 1906, Valletta Hospital; tonsilitis, March 28 to April 2, 1906, Cottonera Hospital. About May 8, 1906, his present illness began with headache and pains in limbs, and he was readmitted to Cottonera with gonorrhœa. He was transferred to Valletta Hospital on May 15, 1906, as a case of Mediterranean Fever. He was in a brothel on April 29. He was on milk diet during the time he was in Valletta and Cottonera Hospitals for tonsilitis, and again at Cottonera on admission of May 9, 1906. For contact in barracks, see Case 20 below. We think this man contracted his disease either in Valletta or Cottonera Hospital. In any case, it is a possible milk infection.

20. Gunner R. was in Upper St. Elmo 1½ years. Came from Room 5. Had been in Cottonera Hospital with rheumatic fever, March 23 to April 23, 1906. His blood gave negative reaction to *Micrococcus melitensis* on March 28, 1906. During that admission he was on milk from March 23 to April 13, 1906. After discharge, he did signalling. He felt ill, and had a swollen right ankle on May 14, and was readmitted to Cottonera on May 15, and was transferred to Valletta Hospital with Mediterranean Fever on May 20, 1906. Blood reacted on May 18. Gunner B. (Case 19), who was admitted May 9, 1906, came from the same room, but from a bed at the far end of the room, and on the opposite side. It was a large room with only six other men in it. Their bloods were examined, but all gave negative reactions. We think that the disease was contracted in Cottonera Hospital, and is a possible milk infection.

21. Sapper F.—Simple continued fever from June 19 to June 27, 1905; simple continued fever from July 7 to July 13, 1905; fissure of anus from October 19 to November 16, 1905; chronic dysentery from January 23 to March 26, 1906, and was transferred to the Sanatorium at Citta Vecchia from March 27 to April 9, 1906. He was again in Cottonera Hospital, with fissure of anus, from April 16 to May 2, 1906. After discharge from Cottonera Hospital, he went to St. Francis Ravelin Barracks, Room No. 3 (only case from this room during the year), and there did light duty, although he was not feeling well, until May 23, 1906, when he felt very ill. He was admitted for Mediterranean Fever on May 30, 1906. He was on plain milk diet for first seven days of his previous admission to Cottonera Hospital, just a month from the time he felt really ill, and which illness proved to be Mediterranean Fever. If this man was not a Mediterranean Fever case from 1905, he most probably contracted it at Cottonera Hospital. During his last stay in Cottonera Hospital there were no Mediterranean Fever patients in it. Milk in Cottonera Hospital is a possible cause. The bloods of 25 men from his barrack room were examined, and that of two men gave a partial reaction (1 in 10). Neither of them were or have been ill. Their urines were also examined, with negative results.

22. Gunner B. was admitted into Valletta Hospital on May 2, 1906, for appendicitis. He was in the surgical ward, and had no contact with Mediterranean Fever cases. He had his appendix removed on May 22. On May 31 he had headache and pains in both legs, and on June 1st, he was sent to the Mediterranean Fever wards. Before the admission for appendicitis he had been in Valletta Hospital from March 26 to April 24 with a previous attack of the same complaint, and in the interval between his discharge and readmission he had been in the guard-room at Tigne Barracks. There is no evidence of contact either in or out of hospital. He was on milk during the whole time of his last admission in Valletta Hospital up to May 21.

Valletta Hospital was taken into use for isolating Mediterranean Fever cases on May 1, 1906, after which date all Mediterranean Fever cases from all parts of the island were sent there for treatment. One possible source of infection, *i.e.*, contact with patients in hospital, ended on the above-mentioned date, for Cottonera, Forrest and Imtarfa Hospitals. Though this source of danger, *i.e.*, handling bed-pans and urinals containing the excreta of Mediterranean Fever patients and their soiled linen, ceased for the Royal Army Medical Corps orderlies at Cottonera, Forrest, and Imtarfa Hospitals, yet it still remained for the orderlies employed at Valletta Hospital. Notwithstanding this fact, the orderlies of the Royal Army Medical

Corps at Valletta enjoyed the same freedom from attack, for the rest of the year, as the orderlies in the other hospitals. There were two apparent exceptions, but, we believe with reason, only apparent and not real exceptions. See Cases 17 and 18 of the Royal Army Medical Corps list. We think the immunity from attack of the Royal Army Medical Corps orderlies at Valletta Hospital was due to the change from goats' milk, as the hospital supply, to condensed milk.

While fully awake to the probability of other paths of infection than milk, we think that occasional lapses from effective sterilisation are a reasonable explanation of the occurrence of cases of Mediterranean Fever among patients, who were or had recently been in hospital suffering from other complaints.

Another possible explanation for some of these cases is infection by flies. When we first visited Valletta Hospital, we noticed numbers of flies on helpless patients, just as they are often observed on enteric cases. This possible source of hospital infection was greatly lessened at Valletta, about the end of June or the middle of July, by the fact that then both the barrack rooms of the men of the Royal Army Medical Corps and the Mediterranean Fever wards were protected from flies by using wire net doors and by fixing mosquito net frames in all the windows. This measure, though perhaps not required for the purpose for which it was originally designed, was most efficient in the exclusion of flies, both from the barrack rooms and wards.

An examination of the diet sheets of patients in Valletta Hospital during the year 1905 seems to afford confirmatory evidence that milk in hospitals has been a causative factor of Mediterranean Fever.

Examination of the Diet Sheets of Patients in Valletta Hospital during 1905.—The diet sheets of patients in Valletta Hospital, during 1905, were examined to see whether there was greater prevalence of Mediterranean Fever among men who had taken milk diet, or extra milk, while in hospital for disease other than Mediterranean Fever, when compared with men who had been in hospital under similar conditions, but without having had milk diet or extra milk. Two thousand and thirty-one diet sheets were examined, of which 190 were found to be useless for the purpose of the enquiry and therefore were rejected. The 190 sheets were those of men who fall under three heads: I. Patients who were admitted into Valletta Hospital for Mediterranean Fever, without having had any previous admission for any other disease during the year; II. Patients who were transferred to Valletta Hospital from other hospitals, and whose previous history is unknown; III. Patients (a few) who had no record of their disease on the diet sheet. After subtracting these 190 from the original total, there remain 1841 diet sheets for examination. Of these, 1460 belong to men who had been in hospital one or more times during the year; all had received either milk diet or extra milk, or both, while the

remaining 381 are those of men who had also been in hospital one or more times during the year, but who had received no milk in hospital, except in tea. Of the 1841 diet sheets, 176 are those of men who were readmitted for Mediterranean Fever, and all of whom had previous admissions during the year for other diseases. Of these 176 men, 172 had had milk in hospital before their admission for Mediterranean Fever; the remaining four men had no milk while in hospital, except in tea. From these figures it appears that 1460 patients who had taken milk when in hospital suffering from diseases other than Mediterranean Fever subsequently gave 172 cases of that disease, while 381 patients who had no milk in hospital subsequently gave four cases. The ratio for the larger group is 11·8 per cent., for the smaller group 1·05 per cent. The 172 patients who were in hospital for one or more diseases within the year and were admitted later for Mediterranean Fever have been classed under three headings. Of the following three tables, No. XI shows the quantity of milk, in pints, which each patient had in hospital, before his readmission for Mediterranean Fever. No. XII the time, in weeks, each patient had milk in hospital, before his readmission for Mediterranean Fever, and No. XIII the interval, in weeks, between the last day on which a patient had milk in hospital and the date of his readmission for Mediteranean Fever.

Table XI.

Quantity of milk in pints	A. Under 5, smallest quantity 3.	B. Over 5, under 10.	C. Over 10, under 20.	D. Over 20, under 40.	E. Over 40, under 60.	F. 60 and over.	Total.
Number of patients...	10	16	31	50	23	42	172
Percentage of patients in each class	5·8	9·3	18·0	29·1	13·4	24·4	100

Table XII.—Length of Time in Weeks during which Patients who later were readmitted for Mediterranean Fever had Milk in Hospital.

Time	A. 1 to 7 days.	B. Over 1, under 2 weeks.	C. Over 2, under 3 weeks.	D. Over 3, under 4 weeks.	E. Over 4, under 5 weeks.	F. Over 5, under 6 weeks.	G. Over 6 weeks.	Total.
Number of patients ...	63	34	28	20	10	4	13	172
Percentage of patients	36 ·6	19 ·8	16 ·3	11 ·6	5 ·8	2 ·3	7 ·6	100

Table XIII.—Interval in Weeks between Date on which Patient had Last Milk and Date of readmission for Mediterranean Fever.

Time	A. Under 1 week.	B. Under 2 weeks.	C. Under 3 weeks.	D. Under 4 weeks.	E. Under 5 weeks.	F. Under 6 weeks.	G. Under 7 weeks.	H. Under 8 weeks.	I. Under 9 weeks.	K. Under 10 weeks.	L. Under 11 weeks.	M. Under 12 weeks.	N. Up to 40 days.	Over 3 months.	Total.
Number of patients	17*	9	9	15	15	25	13	12	8	3	9	4	8	25	172
Percentage of patients	9 ·9	5 ·2	5 ·2	8 ·7	8 ·7	14 ·6	7 ·6	6 ·9	4 ·7	1 ·7	5 ·2	2 ·3	4 ·7	14 ·6	100

* The following six cases, which were those of patients who were taking milk when the diagnosis of Mediterranean Fever was made, have been included in Table XIII—A:—

1. Case No. 38.—Gunner S., 4th Royal Garrison Artillery, was admitted January 9, 1905, with gonorrhœa, and when in hospital with that disease he was diagnosed as a case of Mediterranean Fever on March 8, 1905. He had milk in January, and all through February.

2. Case No. 43.—Private V., admitted August 22, 1905, with enteric fever, during the course of which he was diagnosed, October 8, 1905, as a case in which Mediterranean Fever had supervened. He had milk all through his illness.

3. Case No. 107.—Private G., admitted May 14, 1905, for gonorrhœa. On July 1, 1905, he was diagnosed as Mediterranean Fever. He had had milk during the whole period in hospital.

4. Case No. 113.—Private O., 1st Rifle Brigade, admitted for gonorrhœa on May 2, 1905, and was diagnosed as Mediterranean Fever on June 16, 1905. He had 21 pints of milk in May, and was on milk all through June.

5. Case No. 119.—Private W., admitted May 30, 1905, for enteric fever, and was diagnosed July 16, 1905, as Mediterranean Fever. He had been on milk from first date.

6. Case No. 161.—Acting Bombardier L., Royal Garrison Artillery, admitted September 11, 1905, for liver abscess, and was diagnosed Mediterranean Fever November 10, 1905. He had milk from first date.

The 381 men who had been in hospital, but had no milk, are divided into two groups, men who were not readmitted for Mediterranean Fever, and men who were. In the first group there were 377 men; in the latter group there were four.

Table XIV shows the time, in weeks, spent in hospital by all the men who were not readmitted for Mediterranean Fever.

Table XIV.

Time in weeks...	1 and over.	2 and over.	3 and over.	4 and over.	5 and over.	6 and over.	7 and over.	8 and over.	9 and over.	10 and over.	11 and over.	12 and over.	Total.
Number of men	146	101	44	35	13	8	5	8	2	1	1	13	377
Percentage of men	39·4	26·5	11·5	9·2	3·4	2·1	1·3	2·1	0·6	0·3	0·3	3·4	100

The four men who had been in hospital during the year, but who had no milk, and were admitted during the same year with Mediterranean Fever, had the following history:—

1. Private S. was admitted December 27, 1904, to February 6, 1905, with synovitis of right knee. Had no milk in hospital. He was readmitted on November 8, 1905, with Mediterranean Fever. Interval, in weeks, between discharge from hospital and readmission, 39.

2. Private W. was admitted from December 21, 1904, to January 6, 1905, with rheumatism. He had no milk in hospital. He was readmitted for Mediterranean Fever on May 21, 1905. Interval, in weeks, between discharge and readmission, 19.

3. Gunner R. W. was admitted from February 10 to March 22, 1905, for soft chancre. He had no milk in hospital. He was readmitted November 1, 1905, with Mediterranean Fever. Interval, in weeks, between discharge and readmission, 32.

4. Private W., Royal Army Medical Corps, was admitted from June 4 to June 7, 1905, with contusion. He had no milk in hospital. He was readmitted August 7, 1905, with Mediterranean Fever. Interval, in weeks, between discharge and readmission, 8. (This man was sergeants' mess waiter.)

From the above history it appears extremely unlikely that hospital influence had any causal relation to the subsequent admission of any of these four men.

We think that the deductions which may be drawn from this examination are:—

1. There is evidence that the probability of a patient being subsequently admitted to hospital for Mediterranean Fever bears a direct relation to the quantity of milk he has had in hospital, and

increases with an increase of the milk he had had when in hospital (see Table XI).

2. That there is little relation between the actual length of time any patient was on milk in hospital and the probability of his subsequent readmission for Mediterranean Fever. The relation is rather one of quantity of milk than of time.

3. That over 80 per cent. of men who were readmitted with Mediterranean Fever were readmitted within 90 days from the date on which they last had milk in hospital, while over 50 per cent. of these subsequent readmissions took place within six weeks from the date on which the patient last had milk.

4. That men who have been on milk in hospitals for longer or shorter periods show over 10 times the incidence as compared with men who have not had milk during their previous stay in hospital when suffering from other complaints. It is to be noted further that milk is used in hospitals in much greater quantities during the hot weather months than during the cold, that is to say, a larger quantity of a presumably infected article is then used.

Series 4.—*Other Cases of Possible Milk Infections.*

1. Gunner S., No. 1 Company, Royal Garrison Artillery.—Admitted December 31, 1905, to January 18, 1906, from Fort Benjemma, where he had been for eight months. He stated that, before he got ill, he frequently drank egg flip, and sometimes had goats' milk and soda water. There was no history of contact in this case.

2. Private E., 1st Rifle Brigade. Admitted December 31, 1905, to January 21, 1906, from St. Andrew's Barracks, J block. There was no other case from the room during the year. He stated that he drank goats' milk freely, as he said he thought it did him good. He was admitted for rheumatism, and his disease was changed on January 5, 1906.

3. Private L., 1st Lancashire Fusiliers.—This man came from Room No. 3, Lower St. Elmo. He was admitted on January 1, 1906, from Mellieha Camp. He had two previous admissions for simple continued fever in 1905, namely, from June 12 to June 17, 1905; and again from November 22 to November 27, 1905. He had milk in Cottonera Hospital during his last admission, otherwise only milk in his tea, There is no evidence of contact.

4. Private S., 1st Lancashire Fusiliers.—This case was a probable relapse from 1905. He had been in Citta Vecchia with simple continued fever from July 14 to September 4, 1905. He was readmitted January 4, 1906, with Mediterranean Fever, from Pembroke Camp. He was not personally examined, but a man of his company told one of us that he drank egg flips and rum and milk frequently. This man was a companion of his, and said he had often warned him of the danger of drinking milk, " as the doctor had warned them against milk drinking."

5. Gunner G., 96th Company, Royal Garrison Artillery.—Admitted January 5, 1906, from the officers' mess, where he had been an officer's servant for three months. He slept in a room by himself (No. 7, Servants' Quarters, Castile Mess). There is no history of contact. He had access to milk in the mess.

6. Lance-Corporal T., 1st Lancashire Fusiliers, a relapse from October 30, 1905, to January 15, 1906. He was readmitted February 17, 1906. This man stated that before his first illness he used to drink unboiled goats' milk, but had not done so recently.

7. Gunner L., 102nd Company, Royal Garrison Artillery, was admitted February 20, 1906, from Tigne Old Fort. Was a company cook for three months before he got ill. Goats' milk was used in the cook-house by the cooks, who used to buy it for their own use. This man stated that he had drunk goats' milk and soda water within 30 days of his getting ill.

8. Private W., 1st Lancashire Fusiliers, had been in Valletta Hospital exactly one month before his Mediterranean Fever admission on March 2, 1906, with rhinitis. He said he only drank milk in his tea, but he put the milk into the tea himself, *i.e.*, it was not served with the milk in it.

9. Private T., 1st Lancashire Fusiliers, was employed in the cook-house at Lower St. Elmo for 12 days before he fell ill. He used to drink unboiled goats' milk daily while there. He attributes his illness to this.

10. Private F., 1st Lancashire Fusiliers, was a relapse from 1905. That attack was probably contracted in hospital, as, within a month of his readmission for Mediterranean Fever, he had been in hospital with gonorrhœa, and said that he never felt well after his discharge from hospital after the cure of the gonorrhœa. He had milk in hospital and in his tea.

11. Sergeant M., 2nd Essex Regiment.—Admitted March 21, 1906, at Imtarfa. This case is a possible relapse from August 2, 1905, when he was in with simple continued fever until August 18, 1905, and then had a fortnight's light duty, and since then has suffered from pains in different limbs. He drank goats' milk on several occasions, but cannot give approximate dates. He had had goats' milk in tea in sergeants' mess.

12. Schoolmaster M. was admitted on March 23, 1906, but probably contracted his disease in January last. His wife also had the disease, and probably contracted it at the same time as her husband. They both drank unboiled goats' milk from the herd which supplied the Royal West Kent Regiment. Their son had Mediterranean Fever a year ago, when they were living at Sliema. Mrs. M. then nursed her son, and did not contract the disease. At present they are living in No. 2, Warrant Officers' Quarters, Strada Cappucini, and the son has never lived in the quarters. Several other cases of Mediterranean Fever occurred in this house, and a factor common to all these families was the milk supply.

13. Colour-sergeant S., 4th Worcester Regiment, was admitted into hospital on April 14 from No. 18, Verdala New Married Quarters. This man's child was admitted with Mediterranean Fever on March 2. He had been in camp for some time before his child got ill, but had slept in his house at least twice, February 3 and February 10. He was in Valletta Hospital March 19 to March 28, 1906, for sprain (knee). He and his wife both stated that condensed milk only was used in the house. We have reason to distrust this statement, as we were informed by a responsible officer of the regiment, who knew the family well, that they were well known in the regiment as goats' milk drinkers.

14. Private P., 2nd Essex, was admitted from No. 33 hut, Tigne (military police hut, a hut that has constantly changing inhabitants from different corps in the island), on May 7, after feeling ill for three days. Two other cases occurred of men who had been residents in this hut during the year: 1st, Private G., of the 4th Rifle Brigade, who was admitted on May 21 after leaving this hut only three days. The second case was a man of the West Kent Regiment, Private H. (see Case No. 31, West Kent Regiment), who was admitted into hospital on June 6. This man, however, had left the hut at Tigne over seven weeks when he got ill. None of these men's beds were near each other, and none of the three men were acquainted with each other. Private G., of the 4th Rifle Brigade, we believe, contracted his disease by drinking milk at his sister's house. This man's (G.'s) sister was married to a sergeant of the 1st Rifle Brigade, and he used to visit there

almost daily. The bloods of all the occupants of this hut were examined, with negative results. Private P., we considered, might have possibly contracted Mediterranean Fever by eating Gozo cheese, but we could form no opinion as to where the West Kent case contracted his disease. We did not consider the supervision at Tigne was all that could be desired, *e.g.*, we found that when condensed milk was alone supposed to be in use among the men at Tigne, goats' milk was still in use by the cooks in Tigne cookhouse. We, on one occasion, found goats' milk in the cookhouse. It was unboiled. We cannot exclude contact in the three cases from this hut, but at the time we did not think that contact was at all a sound explanation of them.

15. Private F., 1st Rifle Brigade, had no previous illness in Malta, was admitted on May 18, 1906, after feeling ill for five days. He lived in the Servants' Quarters, officers' mess, St. Andrew's Barracks, where he had a room to himself. He used to drink the milk which was left over from his master's morning tea daily. There is no history of contact. This milk supply was known later to come from a herd which contained infected goats.

16. Private G., 4th Rifle Brigade, was admitted on May 21, 1906, from St. George's Barracks, to which he had only returned from Hut No. 33, Tigne, a few days before. This was the most severe case of all the attacks during 1906 which ended in recovery. The probability of contact has already been discussed in this case (see Case 14). We think P. contracted his disease from milk at his sister's house in St. Andrew's Barracks.

17. Gunner L., 102nd Company Royal Garrison Artillery, was admitted from Room 4, A Block, Tigne, on May 14, 1906. The case is discussed along with Case 18.

18. Gunner H., 102nd Royal Garrison Artillery, was admitted May 25, 1906, from the same room as Gunner L. These men were intimate friends. They were in the habit of knocking about together, and both frequented the "Welcome to All" house at Sliema, where they often had tea together. They only had condensed milk in barracks. Gunner L., though admitted first, probably was ill before Gunner H. All the bloods of the other occupants of Room 4, A Block, were examined, and with negative results. We think that these men contracted their disease at the same time and place, which probably was not Room 4, and, though contact is a possible explanation, yet we do not think that milk infection can be excluded.

19. Gunner L., 99th Company Royal Garrison Artillery, was admitted from Tigne, Hut No. 32, on June 22. This man has complained of severe headaches on and off since April, when he had some teeth extracted. He was employed in Tigne cookhouse, and states he used unboiled goats' milk in his tea. It was in this cook-house we found the cooks using goats' milk, when the only barrack supply was supposed to be condensed milk. This man had been a cook for 13 months. There is no evidence of contact.

20. Sergeant-Major A., King's Own Malta Militia, was admitted on June 30 from 14th Strada Cappucini Warrant Officers' Quarters (see Schoolmaster M.'s case, No. 12, Series 4). His wife was admitted with the same disease May 12, 1906. There were two children in the quarters. The husband and wife used unboiled goats' milk, the children used condensed milk. Neither of the children got ill. It is improbable that the husband contracted the disease from his wife, as she was in hospital since May 12. During Mrs. A.'s stay in hospital she had a confinement, and a few days later *Micrococcus melitensis* was recovered from her milk. Beginning as a mild, she became a very severe attack. Shortly after her husband's admission his blood reacted 1/500,000. The baby which was born began to run a temperature at once, and its curve was exactly parallel with the mother's curve. The baby was bottle-fed, and infection was probably intra-uterine. We consider both Sergeant-Major A. and Mrs. A. to be cases of milk infection.

21. Sergeant K., 2nd Essex, was admitted June 2, 1906, after feeling ill for three days. He came from the Married Quarters, Imtarfa, 1.O Block. The family consists of Mrs. K. and four children. All the family are goats' milk drinkers. Mrs. K. had fever in June last. Sergeant K. had Malta Fever July 8 to July 16, 1904. His present attack is a relapse or a re-infection. This man states that he drank unboiled goats' milk, but not since April 22, 1906. The children in this family are said to have only boiled goats' milk. We consider that this was a milk infection.

22. Bombardier A., 65th Company Royal Garrison Artillery, was admitted from No. 41 Room, Upper St. Elmo, on July 8, 1906, after feeling ill since the end of May. This man, who was a pupil-teacher in the children's school, very frequently drank unboiled goats' milk in different shops in Valletta. There is no evidence of contact. He drank milk up to the time he got ill.

23. Private G., 2nd Essex, was admitted on September 8 from Marsumacetto Barracks, where he was attached to the Garrison Military Police. This man was cook to the police and used to buy a pint of goats' milk daily from any passing goat-herd. He used to drink it unboiled. The milk supply of these barracks is condensed milk.

24. Quartermaster-Sergeant C., Army Ordnance Corps, was admitted on September 7 from No. 7 Strada Birchircara, Sliema. He was a relapse from 1905. Mrs. C. also had Mediterranean Fever this year, and may have been infected through her husband, who this year was found to be excreting *Micrococcus melitensis* in his urine. When Quartermaster-Sergeant C. was ill last year, his son also had the disease at the same time and was nursed by Mrs. C., who then did not contract the disease. All the members of this family drank goats' milk, sometimes boiled and sometimes unboiled. Mrs. C. was under the impression that it was cows' milk they got, but found out later that her milkman only kept goats. Whether Mrs. C. got the disease from her husband or not, there is ample evidence that both father, mother, and son were running daily risk of infection through milk.

25. Private F., 4th Worcesters, was admitted August 13, 1906, from Fort Chambray, Gozo. This man, until 14 days before his admission, was employed in Fort Chambray cook-house, where the milk used was said to be cows' milk. It was this man's duty to sterilise it, and he said he used to use it in his tea. There was no history of contact.

26. Gunner H., 63rd Company, Royal Garrison Artillery, was admitted from Ricasoli on September 8, after having felt ill since July 11, 1906. On June 17, after a cricket match, he drank a quantity of unboiled goat's milk.

27. Gunner W., 65th Company, Royal Garrison Artillery.—After having felt ill since July 7, 1906, was admitted into hospital on September 7. This man had drunk goats' milk freely at Pembroke Camp in June last, and said it was commonly done in camp. He also drank egg flips, which contained goats' milk. This man was in Room 39, Upper St. Elmo, for the past 12 months, and no other case has occurred in the room this year. There is no history of contact. We believe this man, though only admitted in September, contracted his disease at Pembroke Camp in June, where he was from June 1 to June 14, as he began to feel ill within three weeks of leaving camp.

Series 5. *Men who were Probably Infected through Animals other than Goats.*

Gunner L., 65th Company, Royal Garrison Artillery, was admitted to hospital on July 30, 1906, and his blood reacted on the same day. He had felt ill for two days before his admission with headache and general malaise. He is the second case admitted from St. James Cavalier during the year. The first was Gunner N. (see

(Case 8, Hospital List), who came from another room. Gunner L. came from Room 5, and had been in this room for three years. His employment was that of groom to Captain S.'s ponies. The stables where he worked were in St. James's Ditch, the surroundings of which were not in a very sanitary condition. The man's diet throws no light on the cause of his disease. One of the ponies with which he worked, pony "Billy," gave a good reaction against *Micrococcus melitensis.* This fact was not discovered until September, when another groom, Gunner W., was admitted (September 3, 1906) from the same room as Gunner L. had come from. W.'s blood, like that of the first groom, gave a positive reaction on the day of his admission. Gunner L. and Gunner W. had worked in the same stable, and both "had to do" with pony "Billy" and pony "Benghiza," the bloods of which ponies reacted well to *Micrococcus melitensis.* The bloods of eight men from Room 5 were examined at the same time, and none of them gave a positive reaction. Neither Gunner L. nor Gunner W. had ever taken goats' milk, and it seems highly probable that these men were infected through handling infected ponies. As to the way the ponies may have been infected it seems not improbable that their food may have been infected by urine of goats which a short time before used to be kept in large numbers in St. James's Ditch. None of the other occupants of the rooms got the disease, and none of them were grooms. It is much more probable that the ponies were the source of contagion than anything in the barrack room.

Gunner H., 99th Company, Royal Garrison Artillery, was another case in which we could find no other likely source than through infection from a pony. He lived in 21, Strada Jacinta Sliema, was groom to Captain A.'s ponies, and worked with a pony whose blood reacted well (1 in 10, and 1 in 20). Gunner H. was a married man, and had lived in his present house for the past six months. The house was in good sanitary condition, and no case of illness had occurred in it. His wife was in good health, and her blood gave a negative reaction. Gunner H. first fell ill on August 14, 1906, and was admitted to hospital on August 21. His blood reacted on August 20. The case from the first was one of great severity. Goats' milk was never used in his house. There was no evidence of contact except with the pony. The blood of the pony was examined for *Micrococcus melitensis*, but the attempt to recover it was unsuccessful. This is not a frequent path of infection, as the risk is confined to a very limited class of persons.

The remaining 33 cases have not been detailed, as we were unable to come to any definite opinion as to their causation, and they throw no light on the question of contact or other path of infection.

6. *Occupation in Relation to Attack.*

The liability to attack of the men of the Royal Army Medical Corps has already been discussed and need not be further referred to. In barracks, cooks, officers' servants and mess waiters have suffered severely.

Sixteen men employed in barrack cook-houses contracted the disease during the year, 12 of them being cases that occurred prior to the milk change. In nearly every instance there is a history of taking goats' milk.

Twelve men who were employed as officers' servants contracted Mediterranean Fever during the year, and in every case they were employed during the time when goats' milk was being used in the

officers' mess; or in instances where it had been stopped, the men fell ill within 30 days of the time when the mess ceased to use goats' milk.

Six men who were employed as mess waiters contracted the disease during the year, and all at the time the messes were using goats' milk. After the milk change this class of case ceased.

There does not appear to be any special liability to attack on the part of men who had been employed on sanitary work, such as work connected with drains, urinals, moving urine tubs, latrine work, etc.

The three cases of grooms which have just been detailed, and the three laboratory attendants who contracted the disease—one in 1905 and two in 1906—are of interest as pointing to contact as the path of infection.

7. *Prevalence amongst Officers.*

During 1906, 10 officers contracted Mediterranean Fever. One was an officer of the Royal Garrison Artillery about whom we obtained no information, except that goats' milk was used at the mess where he lived, and that it was used unboiled. Four were officers of the Royal West Kent Regiment. Lieutenant F. was admitted to hospital on March 18 after feeling ill for a fortnight. Lieutenant L. W. was admitted on April 16 after feeling ill for two days. Lieutenant W. was admitted on May 8 after feeling ill for four days. Captain S. was admitted on June 3, but had been feeling ill since the end of April. None of these officers had any real contact with each other beyond living in the same building and having meals together. No two cases occurred from one room. All these officers stated that they had only used boiled milk so far as they knew. Orders had been given that all goats' milk was to be boiled, and the Mess President was quite confident that these orders had been strictly enforced. By means of the ortol test it was proved on several occasions that the milk had not been boiled. All the West Kent officers got ill before they had ceased using goats' milk in the mess. Condensed milk was taken into use on May 25. Captain S., though admitted in June, was ill from the end of April.

Two officers of the 1st Rifle Brigade got ill about the same time. Lieutenant Hon. W. was admitted on April 21 after feeling ill for about a week. Captain D. was admitted on April 25 after feeling ill for 10 days. We could find no connecting link between these two officers, except that one of them began to take porridge and milk three weeks before he got ill, while the other officer had begun taking porridge and milk a month before he got ill. One of the officers said he knew the milk was boiled, because on the first occasion he used it it was hot, but that he always got the milk cold

afterwards, as he had scolded his servant for bringing him hot milk. It appears probable, in consequence of this scolding, that the officers in future had unboiled milk. There was no evidence of contact in either of these cases.

Captain P., Hampshire Regiment, was admitted to hospital on June 10, after feeling ill for a week. He was living in private lodgings and used to have all his meals, except his breakfast, at the Union Club. This officer's servant got ill about three weeks before his master. He used to use unboiled goats' milk for his tea. His servant used to have tea at his master's quarters. We think that master and servant were most probably infected by milk.

Lieutenant B., 4th Worcester Regiment, was admitted into hospital on July 1 from the Officers' Quarters, Verdala Barracks. This officer was on the sick list for five days about Christmas, 1905, with simple continued fever, and again in Egypt he had another attack of fever which lasted for a few days. This was about May 20. Since then he has never felt fit and had headache frequently. This officer used to take porridge and goats' milk before he went to Egypt, not since he returned to Malta. It is extremely probable that the disease was contracted before he went to Egypt. There is no evidence of contact. No other officer of this regiment has had the disease this year.

Lieut.-Colonel Y., Army Pay Department, was placed on the sick list on October 11, 1906. We know nothing about this officer's illness, which took place after we left Malta.

The deductions to be drawn from the incidence of the disease among officers are :—1. In the cases of the officers about whom we obtained personal information, all except two, there was a history of drinking goats' milk. 2. Since goats' milk has been discontinued, no other officer has been attacked by Mediterranean Fever.

8. *Prevalence in Married Quarters.*

A family forms a small group of individuals living in close association, and in each set of married quarters there are many such small groups, each living amidst the same general surroundings, but differing from each other often in one important respect, namely, in regard to the kind of milk used.

This year's examination of the kind of milk used by the families showed the following results.

Four hundred and sixty-five families were examined. These families comprised 1830 persons, 465 men, 465 women, and 900 children. Among them there occurred, during the year, 59 cases of Mediterranean Fever, 3·2 per cent. The men gave 21 cases, and the women and children each gave 19 cases, the respective ratios being, men 4·5 per cent., women 4·1 per cent., children 2·1 per cent.; 266 families, composed of 266 men, 266 women, and 436 children, with a total of 968 persons, whose only supply was condensed milk, gave 10 cases of Mediterranean Fever, 1·03 per cent.; while

199 families, consisting of 199 men, 199 women, and 464 children, total = 862 persons, whose milk supply was either goats' milk alone or goats' milk and condensed milk, gave 46 cases of Mediterranean Fever, being a ratio of 5·3 per cent.

	Per cent.
Of the 21 men, 15 had goats' milk	71·5
,, 4 had condensed milk.........	19·0
,, 2 milk supply unknown	9·5

These four men include one (Sergeant S.) whose milk history is unknown and he is assumed to have used condensed milk only.

	Per cent.
Of the 19 women, 9 had unboiled goats' milk	47·4
,, 8 had boiled goats' milk	42·1
,, 2 had condensed milk only	10·5
Of the 19 children, 8 had boiled goats' milk	42·1
,, 5 had unboiled goats' milk	26·3
,, 4 had condensed milk	21·1
The histories of two are unknown	10·5

It is seen that, for this year, families whose only supply was condensed milk give a Mediterranean Fever rate of 1·03 per cent., while families which used goats' milk, either entirely or in part, give a rate of 5·3 per cent., *i.e.*, there are more than five times as many cases in the group using the dangerous article than among those using the safe one. The figures obtained with regard to those who used boiled goats' milk as compared with those who used unboiled goats' milk do not show the same amount of protection as is shown by the condensed milk group compared with the goats' milk group. This is only what one might expect. In our inquiry some women said they boiled the milk always, others said the milk was sometimes boiled, not always, others again said it was "scalded," and again that it was only used unboiled for tea. The only safe comparison to make, or one which with any degree of probability represents the truth, is the comparison of families which used condensed milk against families which used goats' milk, boiled or unboiled, and, using this comparison, the figures are all in favour of the condensed milk users.

The following table gives the monthly distribution of the disease among the married men, women and children during the year.

1906.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Men	1	0	1	3	3	6	1	2	1	1	1	1	21
Women	0	1	0	3	7	1	2	1	2	0	1	1	19
Children	0	1	2	0	5	1	5	3	0	1	1	—	19

During the first six months of the year the men had 14 cases of Mediterranean Fever and during the second half of the year seven cases.

The women, during the first six months, gave 12 cases, during the second six months seven cases of Mediterranean Fever.

The children, during the first six months, gave nine cases, and during the second six months ten cases of Mediterranean Fever.

There are no data against which these figures can be compared, as no monthly distribution of the disease among families has been given in previous records.

9. *Mosquitoes and other Biting Insects.*

In none of the cases examined this year could we obtain any evidence of the spread of Mediterranean Fever through the agency of mosquitoes or other biting insects. The majority of the patients stated that they had not been bitten, and at the time we examined them they had no visible marks. Such evidence is, of course, very weak for determining a question of this nature. Evidence on which we place more importance is, that we examined a large number of men in barracks, and of children in quarters, who had been severely bitten by both mosquitoes and sand flies, some sufficiently badly bitten as to cause their admission to hospital through injury to the skin caused by scratching. None of these severely bitten individuals were subsequently admitted with Mediterranean Fever. It is hard to believe, supposing the mosquito to play any large part in the spread of this fever, that this should have been the case. The disease was also most prevalent in the first six months of 1906, when mosquitoes were few, and the prevalence was far less in July, August, and September, when they were abundant.

From May to the end of September we examined 222 mosquitoes sent to us from different barracks in Malta, with the following results: From Floriana Barracks 97 specimens were examined, of which 52

were *Culex pipiens* or *fatigans*, 29 were *Stegomyia fasciata*, and 16 were *Culex spathipalpis*. From St. George's Barracks—39 mosquitoes, of which 23 were *Culex pipiens*, 10 were *Acartomyia Zammitii*, and 6 were *Stegomyia fasciata*. From St. Andrew's Barracks we received 42 mosquitoes, of which 27 were *Culex pipiens*, 11 were *Stegomyia fasciata*, and 4 were *Acartomyia Zammitii*. From Tigne Barracks and married quarters 44 mosquitoes were received, of which 16 were *Culex pipiens*, 18 were *Stegomyia fasciata*, and 10 were *Acartomyia Zammitii*.

As the *Stegomyia fasciata* did not appear until June, and the *Acartomyia Zammitii* ceases in September, neither of these species can have much to say to the occurrence of cases during the cold weather months.

On the initiative of the Principal Medical Officer, Colonel MacNeece, a joint Committee, consisting of representatives of the Civil Government, and the naval and military authorities, was appointed to discuss the question of ways and means of lessening mosquito prevalence in Malta. The Committee had not reported up to the time we left the Command.

10. *Preventive Measures.*

The measures in use when we arrived in Malta were as follows :—

The sanitary conditions of barracks and quarters were under constant supervision, and there was much sanitary activity on the part of both medical and regimental authorities. Courses of lectures are regularly given by the Command sanitary officer, Major W. L. Gray, R.A.M.C., on subjects relating to barrack sanitation and the laws of health.

In barracks and married quarters, the sterilisation of goats' milk by boiling had been strictly enjoined, and the hospital supplies were dealt with by pasteurisation in the case of Valletta and Cottonera, and by boiling in the case of the other hospitals.

Special care was being paid to keeping latrines and urinals in a satisfactory sanitary state.

The kit, bedding, and clothing of every man reporting sick with fever was set aside in a store reserved in each barracks for the purpose, until it could be disinfected. Spraying, steeping, and steam disinfection were the methods in use.

A sample of blood was taken from each case of fever, and was sent to the laboratory for examination.

On a case being diagnosed Mediterranean Fever, the sanitary officer and others concerned were immediately notified.

If a second case of Mediterranean Fever was admitted from the same barrack room, the room was evacuated and it was disinfected by spraying, scraping, and limewashing.

In hospitals, special feeding cups, urinals, and bedpans were set aside and marked for the use of Mediterranean Fever patients.

Attendants on the sick had strict instructions to be careful as to personal disinfection, and there was a standing order that they were to wash their hands in a disinfectant and to use the nail brush immediately after handling bedpans, soiled bedding, and clothing, etc.

Questions relating to the application of additional preventive measures were discussed with the Principal Medical Officer from time to time as occasion arose, and twice in conference with H.E. the Governor. At the first of these conferences it was represented that, in order of importance, practical measures were: alteration of the milk supply; isolation of cases; disinfection; segregation and observation of contacts; care that the men get their full 750 cubic feet space; and attention to general sanitation.

The Milk Supply.—The discontinuance of the use of goats' milk in barracks and hospitals was pushed at the end of April. It became an accomplished fact in hospitals by May 17, and in barracks between that date and June 7. The details have already been fully discussed (p. 166).

Isolation of Cases.—Shortly before our arrival in Malta the question of isolating cases of Mediterranean Fever in one hospital was raised by the Principal Medical Officer, and it had been decided to let it stand over until the Members of the Commission arrived. After discussion, it was decided to use Valletta Hospital, as it was centrally situated, and also because it was the most convenient from an administrative point of view. Accordingly, the hospital began to be used for this special purpose from May 1, 1906. We recommend the continuance of the practice of isolating cases of Mediterranean Fever.

As Valletta Hospital is situated in a densely populated neighbourhood, where mosquitoes are generally plentiful, it was resolved to make the windows and doors of the wards mosquito-proof, so as to prevent the entrance of mosquitoes and the possible carriage of infection by them. The windows and doors of the rooms used as barrack rooms by the detachment of the Royal Army Medical Corps were also mosquito netted. We now think that, as infection is probably seldom, if ever, conveyed by mosquitoes, this measure was perhaps one that might have been dispensed with, although it certainly was useful in excluding mosquitoes and also flies. It was considered by the staff and by the nursing sisters that the mosquito netting, even although the windows were constantly open, interfered with the free passage of air and rendered the wards uncomfortably close. The same view was strongly held by the men with regard to the barrack room netting. On the whole, the balance of evidence is against renewing it.

Segregation and Observation of Contacts.—The procedure recommended and which was adopted was as follows:—

(1) To enable the disinfection of barrack rooms to be thoroughly carried out. The room was evacuated, and separate accommodation was found for the men until the disinfection of the room had been completed, after which they were allowed to return to it.

(2) For the detection of ambulatory cases. The "contacts" were kept under observation and examinations for agglutination reactions were carried out.

(3) Men who had been discharged from hospital after treatment for fever were kept under observation.

Examination of Blood of "Contacts" and others.—Five hundred and seventy-four samples of blood were examined during the year.

Thirty samples were taken from men of the 2nd Battalion Essex Regiment, who had had Mediterranean Fever in 1904 and 1905. Twenty-eight gave a positive reaction against *Micrococcus melitensis.*

Six ponies were examined as contacts, of which the blood of three gave a positive reaction.

Bloods from 140 Maltese, employed in barracks, were examined, of which 11 gave a positive reaction. These include one man whose serum reacted against both *Micrococcus melitensis* and a *paratyphoid bacillus*, and another man whose serum reacted against a *paratyphoid bacillus* only. The last case was diagnosed simple continued fever. Excluding this case, positive reactions were obtained in 7·7 per cent. of the Maltese examined.

Three hundred and seventy samples of blood from men of British troops were examined, 37 of which gave a positive reaction against *Micrococcus melitensis*—that is, 9·2 per cent.

The blood of one British soldier gave a positive reaction against a *paratyphoid bacillus.*

The urine of 26 cases was examined for the presence of *Micrococcus melitensis.* It was recovered once from the urine of a married man, whose wife contracted the disease during the summer of 1906. Her husband was a relapse from the previous year. The wife, no doubt, may have been infected from this source; but both husband and wife drank goats' milk freely, so that possibility of milk infection cannot be excluded.

The blood of "contacts" of 18 families was examined. In three a positive reaction was obtained; all three were persons who never manifested any symptoms of Mediterranean Fever.

Positive reaction without symptoms was also observed in the case of four men of the Royal Engineers. Seventy-four samples of blood were examined from men of this corps, and four gave a positive reaction against *Micrococcus melitensis.* These four men had never been ill, and have not since manifested any symptoms of the disease.

The dilutions used in the blood examinations were 1 in 10 and 1 in 20. The examinations were made in the laboratory of the Mediterranean Fever Commission.

From these examinations it appears that the blood of individuals who have no history of previous attack, and who do not for long periods after manifest any apparent symptoms, may give a positive reaction. We understand by this phenomenon that certain persons may be invaded by *Micrococcus melitensis* without showing any signs of illness.

Although we were on the look out for cases in which the disease might have been contracted from ambulatory cases, and we also thought that special liability might be shown by men employed in keeping latrines and urinals clean, or in handling urine tubs, we failed to observe any such cases. The three laboratory cases, the three men who were admitted for Mediterranean Fever, and who were found to have been constantly grooming ponies the blood of which gave good positive reactions, the probability that goats themselves may be infected through breaches of the surface, make it evident that contact cannot altogether be disregarded. In view of the fact, however, that close association with cases of the disease in the Home hospitals, both as regards sick attendants and patients under treatment in the same wards for other ailments, has never been known to result in the spread of Mediterranean Fever, contact is probably an infrequent factor.

Disinfection.—Up to the middle of April, 1906, the practice was to carry out disinfection of kit and bedding in every case of Mediterranean Fever, but the room was not disinfected unless a second case occurred in it. This was altered to disinfection of the room on the occurrence of the first case. If subsequent cases occurred, the bedding and clothing of the case was dealt with, but the room was not again disinfected unless required by special circumstances, and such, as a matter of fact, never occurred. The disinfection arrangements were carried into effect under the supervision of the sanitary officer, Major Gray.

Attention to General Sanitation.—A good deal of care was bestowed on the condition of latrines, urinals, urine tubs, and urine tub stands on account of the possibility of such places being fouled by infected urine, but, as we have just pointed out, we have no evidence of the spread of Mediterranean Fever in this way. It was suggested that latrine seats should be scrubbed daily with a 2½-per-cent. carbolic solution, and that all other woodwork should be scrubbed once a week. In the case of dry earth closets, placing carbolic solution in the pails was recommended, and, to prevent spillage, that a spadeful or two of dry earth might be added to the contents before the pail was moved. Urine tubs and urine tub stands were to be kept scrupulously clean, and it was suggested that arrangements should be made for providing means for washing the hands of men employed on urine tub fatigues. Swarms of flies round ashbins were often noticed. This was caused by the

contents getting strewn over the ground, through the doors being left open, and the covers left up. Flies were often observed to be abundant in kitchens, and especially in the places where cooking is carried on in the regimental coffee shops. This was usually due to grease stains about the tables or on the floors. Regular scrubbing keeps down their number largely. Flies were often present in large numbers in latrines, and we found an excellent plan in use in the St. Andrew's Barracks, namely, the application of a thin layer of kerosene oil once or twice a week to all woodwork about the latrine, except the seats. It does not take much, and these latrines were remarkably free from flies.

Special Sanitary Staff.—At the time we left Malta, all the infantry units had adopted the plan of having the sanitary work in barracks done by a permanent staff of men, consisting of two men per company under the orders of the quartermaster, in place of the old practice of having one or two permanent men and having the greater part of the sanitary work done by fatigue parties. One or two of the quartermasters informed us that they had found the change of the greatest help to them, and that they could get sanitary work more systematically and, therefore, more efficiently done.

11. *Results of the Work of* 1906.

The conclusions drawn from a critical examination of the military and naval observations are given in detail in the general summary (p. 244). It may be stated here, however, that the investigations relating to the garrison indicate :—

1. That the goat is the primary source from which the disease is spread to man.
2. That goats' milk is the common vehicle for the *Micrococcus melitensis.*
3. That flies may act as carriers.
4. That the other paths of infection play but a minor part. Contact and dust are possible, but probably very infrequent, factors, while the case for mosquitoes or other biting insects is not proven.

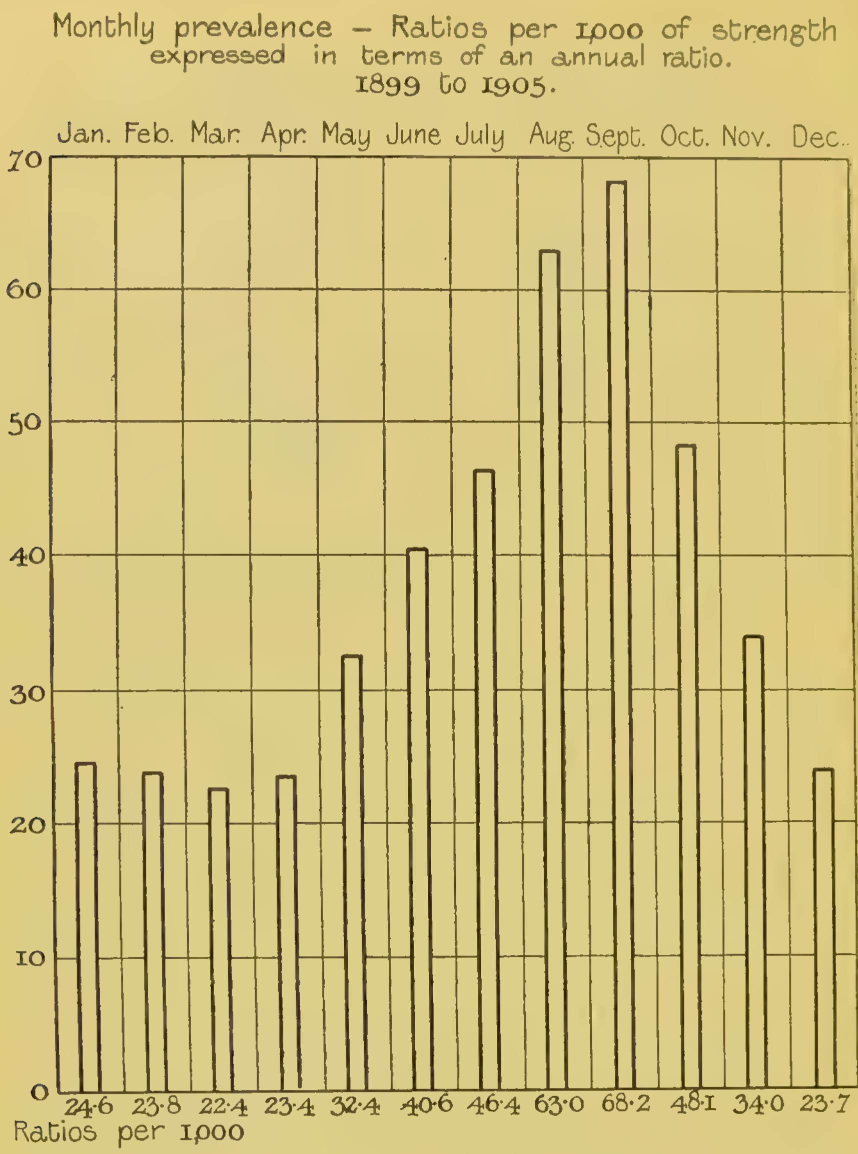
The use of goats' milk is the one factor which has come into special prominence in the investigations of the probable causation of cases of the disease in 1906. A history of goats' milk was traced in 70·6 per cent. of the cases investigated up to the time we left Malta at the end of September. Those who are most in the way of using milk appear to be most liable to attack—for instance, officers are more liable to attack than men; and, probably for a similar reason, a special liability appears to attach to certain occupations, such as cooks, officers' servants, and mess waiters.

The cutting off of the use of goats' milk from barracks and hospitals has constituted an experiment on a very large scale, and one that has been, so far, attended by exceedingly satisfactory results, as will be observed from a study of the following tables and Charts 5 and 6 :—

Table XV.

Year.	Mediterranean Fever. Admissions.	Simple continued fever. Admissions.	Enteric fever. Admissions.	Total admissions for continued fevers.	Mediterranean Fever. Ratios per 1000. Admissions.	Mediterranean Fever. Ratios per 1000. Deaths.	Simple continued fever. Ratios per 1000 admissions.	Enteric fever. Ratios per 1000 admissions.	Total continued fevers. Ratios per 1000 admissions.
1897	279	1275	34	1588	34 ·7	1 ·49	158 ·9	4 ·2	197 ·9
1898	200	1509	62	1771	27 ·1	1 ·08	204 ·2	8 ·4	239 ·6
1899	275	1107	41	1423	37 ·0	1 ·21	149 ·1	5 ·5	191 ·6
1900	158	1158	31	1347	19 ·4	0 ·98	142 ·2	3 ·8	165 ·5
1901	253	1205	41	1499	31 ·1	1 ·10	148 ·1	5 ·0	184 ·2
1902	155	981	38	1174	17 ·7	0 ·68	112 ·0	4 ·3	134 ·0
1903	404	781	18	1203	45 ·4	1 ·01	87 ·7	2 ·0	135 ·1
1904	320	1350	79	1749	35 ·1	1 ·32	148 ·0	8 ·7	191 ·8
1905	643	1199	64	1906	77 ·5	1 ·93	144 ·6	7 ·7	229 ·8
1906	163*	504	9	676	24 ·5†	0 ·15	75 ·6	1 ·4	101 ·5

* Includes 19 readmissions.
† Excluding readmissions, the ratio is 21 ·6.



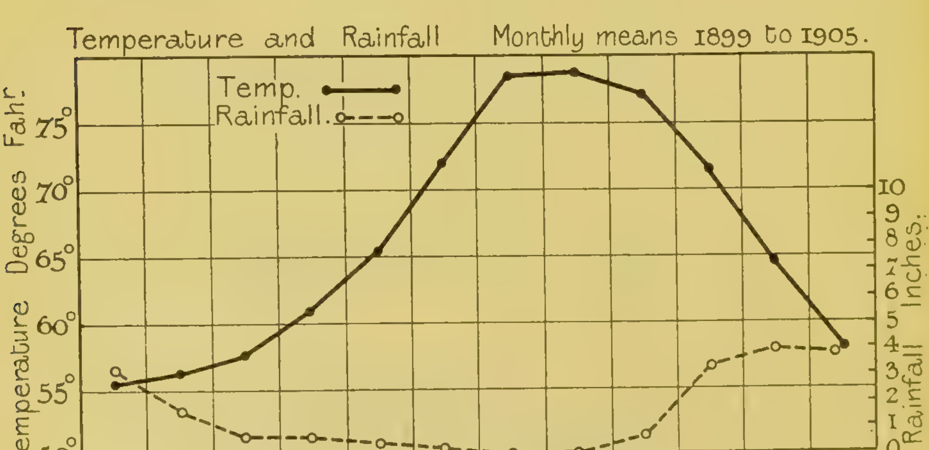


Chart 5.—Mediterranean Fever amongst the troops in Malta.

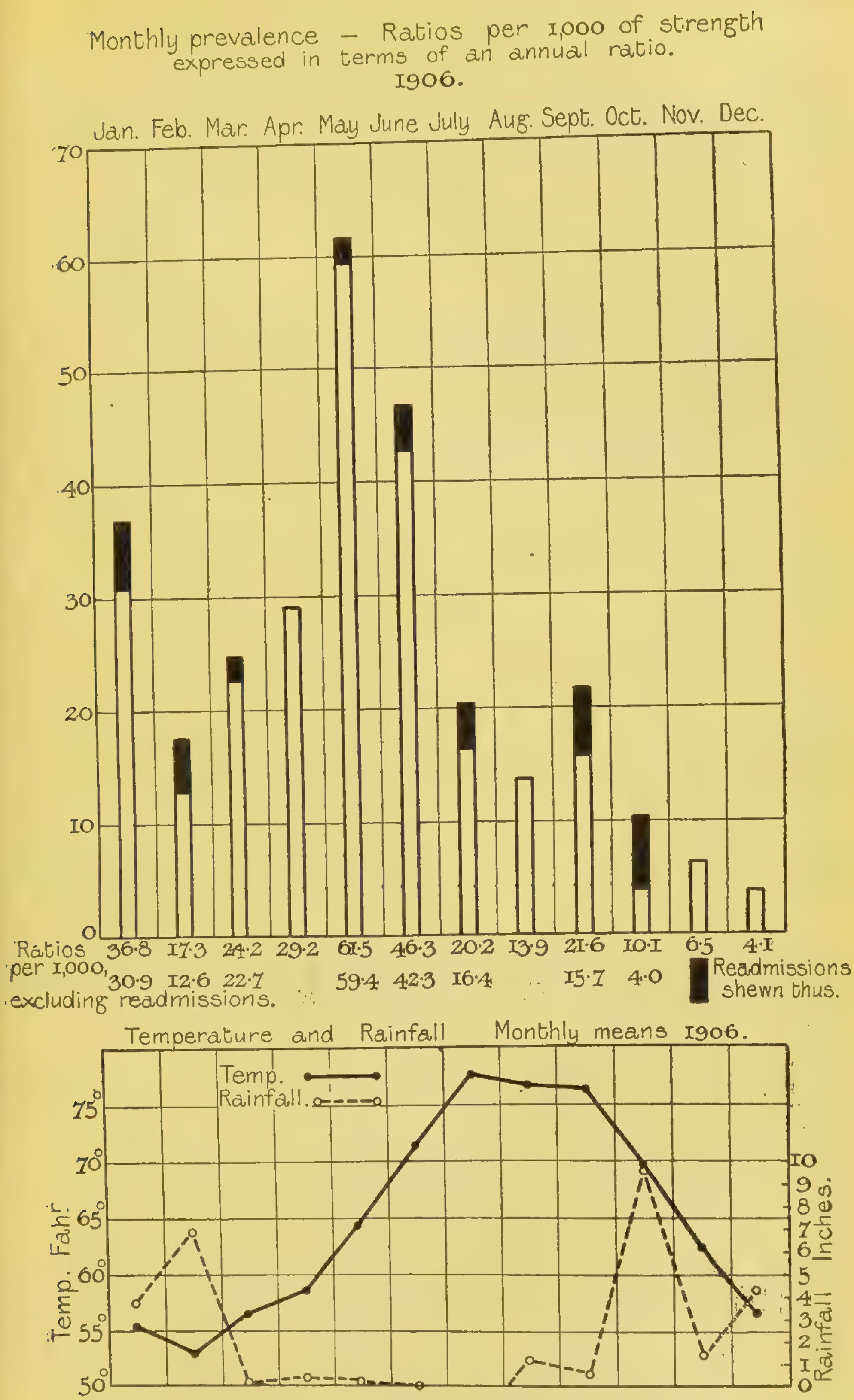


Chart 5.—Mediterranean Fever amongst the troops in Malta.

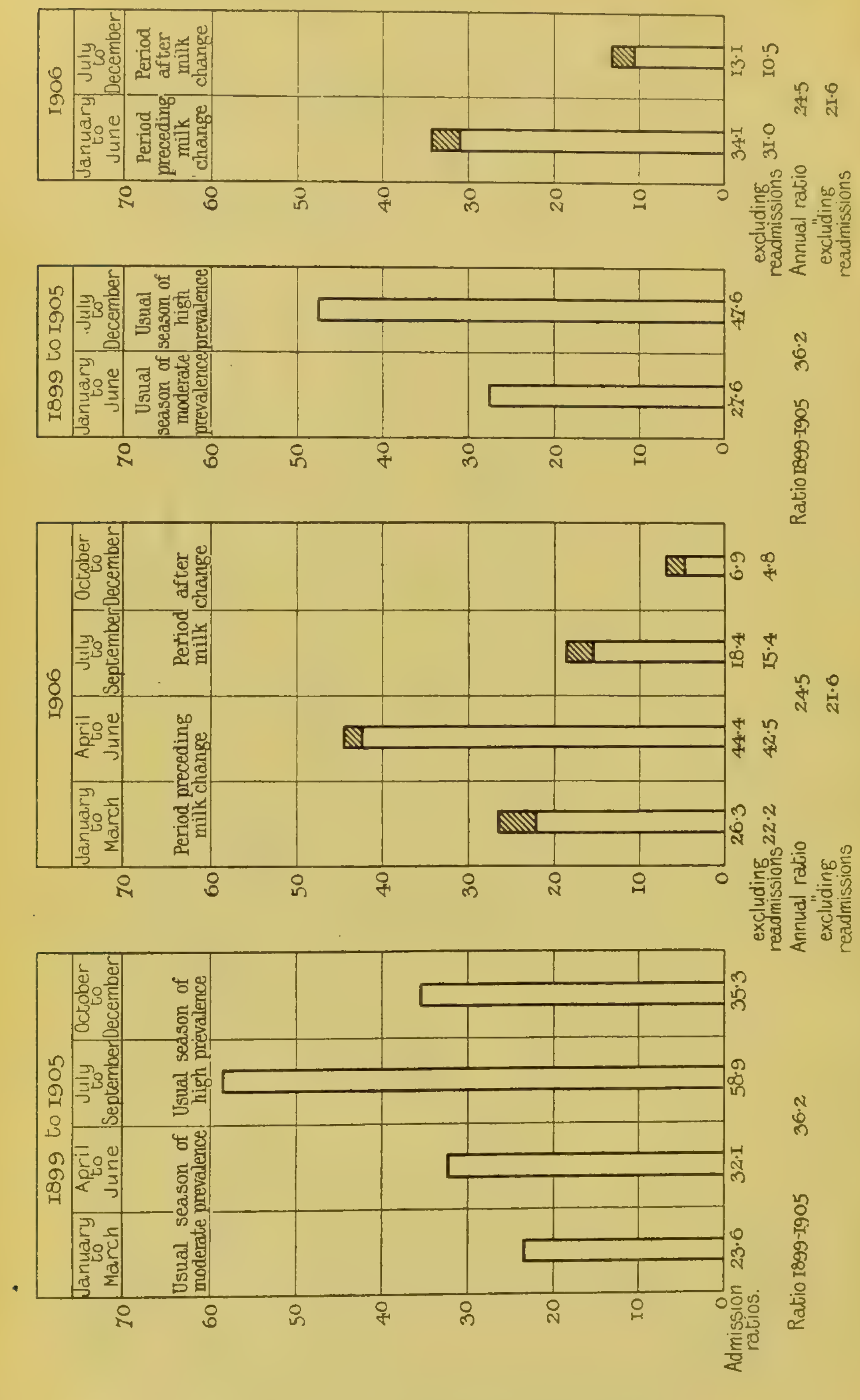


Chart 6.—Prevalence of Mediterranean Fever in 1906 as compared with 1899—1905, to show the reduction of prevalence during the last six months of 1906.

Table XVI shows the monthly prevalence of Mediterranean Fever in the Malta garrison during 1906. Tables XVII and XVIII give similar information regarding simple continued and enteric fevers. The average number of cases and the average ratios for the seven years' period 1899 to 1905 are added in each instance for comparison.

Table XVI.—Mediterranean Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906 ...	25	11	16	18	30	23	11	8	11	5	3	2
Monthly average 1899—1905	18	15	16	16	23	28	34	45	46	34	23	17
Ratios—												
1906	36 ·8	17 ·3	24 ·2	29 ·2	61 ·5	46 ·3	20 ·2	13 ·9	21 ·6	10 ·1	6 ·5	4 ·1
1899—1905	24 ·6	23 ·8	22 ·4	23 ·4	32 ·4	40 ·6	46 ·4	63 ·0	68 ·2	48 ·1	34 ·0	23 ·7

Table XVII.—Simple Continued Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906	5	3	4	7	9	117	185	66	61	29	15	3
Monthly average 1899—1905	15	11	19	23	32	164	308	212	181	69	23	13
Ratios—												
1906	7 ·4	3 ·2	3 ·0	6 ·5	18 ·5	215 ·4	331 ·4	114 ·6	120 ·0	58 ·6	32 ·4	6 ·1
1899—1905 ...	21 ·0	16 ·4	26 ·4	33 ·2	45 ·7	238 ·1	426 ·1	297 ·4	266 ·7	97 ·0	33 ·2	19 ·2

Table XVIII.—Enteric Fever.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Admissions 1906 ...	1	—	—	4	3	—	—	1	—	—	—	—
Monthly average 1899—1905	3	2	3	1	1	3	7	6	3	5	5	5
Ratios—												
1906	1 ·5	—	—	6 ·5	6 ·2	—	—	1 ·8	—	—	—	—
1899—1905	3 ·60	3 ·28	4 ·81	1 ·44	1 ·81	3 ·73	10 ·08	8 ·61	4 ·85	7 ·85	6 ·60	6 ·95

The satisfactory character of the decreased prevalence observed during the second half of 1906 is even better shown by tabulating the figures relating to Mediterranean Fever incidence by quarters (see also Chart 6).

Table XIX.—Mediterranean Fever.

Comparison of 1906 with the Period 1899—1905, by Quarters of the Year.

	January to March.	April to June.	July to September.	October to December.
Admissions, 1906* ...	52	71	30	10
Average for period 1899—1905	49	67	125	74
Ratios, 1906	26·3	44·4	18·4	6·9
Average for period 1899—1905	23·6	32·1	58·9	35·3
* 1906, excluding re-admissions—Ratios	22·2	42·5	15·4	4·8

While it is shown even better still by dividing the year into two six months' periods, and the more so because the first six months represents the period preceding the milk change, and the second six months the period after the milk change.

Table XX.—Mediterranean Fever.

Comparison of 1906 with the Period 1899—1905, by Half Years.

	Admissions.		Ratios per 1000.	
	January to June.	July to December.	January to June.	July to December.
1906*	123	40	34·1	13·1
Average for period 1899—1905	116	199	27·6	47·6
* 1906, excluding re-admissions	112	32	31·0	10·5

In the two units which showed most prevalence in 1906 the disease was practically confined to the first half of the year.

1st Battalion Royal West Kent Regiment.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
7	3	6	6	8	10	—	2	2	—	—	—

See also remarks at the end of the discussion of the cases which occurred in this regiment (p. 192).

Royal Army Medical Corps.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
3	3	1	3	5	1	—	—	2	—	—	—

See also remarks (p. 200).

The prevalence amongst officers was also chiefly confined to the first six months of 1906.

Officers.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	1	2	2	2	1	—	—	1	—	—

The prevalence amongst soldiers' wives is not so strictly confined to the first half of the year, and the figures for the children are nearly equally distributed between the two halves of the year. It is difficult to control the introduction of goats' milk into married quarters. The last two cases amongst the women, reported in November and December respectively, used goats' milk. The Principal Medical Officer, Malta, makes the following comment regarding one of these cases:—"I find that in spite of personal warnings and the prevention of goats entering barracks, married people persist in obtaining goats' milk outside." Commanding officers are communicated with when such cases come under observation.

Soldiers' Wives.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	—	3	7	1	2	1	2	—	1	1

Children.

January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
—	1	2	—	5	1	5	3	—	1	1	—

It may be reasonably claimed that since the use of goats' milk was discontinued in barracks and hospitals there has been a great reduction in the prevalence of Mediterranean Fever. This is well shown in Tables XIX and XX and Chart 6. By a glance at Chart 6 it will be observed that Mediterranean Fever showed more than average prevalence during the six months of 1906, in comparison with the corresponding months of the seven years' period 1899—1905. This seemed to presage that in the second half of the year, the period when the disease is generally at its worst, more than ordinary prevalence was to be expected, instead of which the very reverse has happened. Concurrently there has also been a reduction in the admissions for simple continued fevers, which was also most marked in the second half of the year. We may have here foreshadowed the decline of Mediterranean and simple continued fevers in Malta, just as we have already seen in the first part of this report that their disappearance from Gibraltar was also simultaneous in character.

It is, of course, impossible to build upon six months' results as on a sure foundation. If, however, the milk change is the true explanation of the reduction, it will stand the test of time, and by that alone can the importance of goats' milk as the chief causative factor be established. But it must, at the same time, be remembered, that unless the dangers of infected goats' milk are being constantly kept in view, and constantly brought to the notice of soldiers and soldiers' families, there is always the possibility of lapse to old ways, with its attendant risks of spread of the disease.

Division III.—CIVIL.

We do not propose to enter upon a detailed discussion of the prevalence of Mediterranean Fever amongst the civil population. Accurate information is difficult to obtain, and the subject of civil prevalence has already been dealt with by Dr. Johnstone in the 1904 Reports, together with topographical details and a general sanitary survey of the Maltese islands. We accordingly limit ourselves to bringing distribution tables up to date, and to a brief discussion of some of the more important points connected with the disease as observed amongst the civil population.

1. *Prevalence of the Fever among the Civil Population.*

The following table shows the monthly distribution of cases in 1906, compared with the average monthly prevalence during the 10 years 1896 to 1905 :—

Table I.—Civil Population. Monthly Distribution of Cases in 1906.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Average— 1896—1905	32	26	30	30	48	58	87	87	69	64	52	49	632
1906	20	27	28	54	81	109	108	103	71	32	37	28	698

This table shows that cases of Mediterranean Fever are notified all through the year, and that there is an increase in the notifications during the hot weather months.

The notifications for 1906 showed increased prevalence up to the end of September, after which they are below the average during the three last months of the year. The improvement indicated by the figures for the last quarter may possibly be the result of the attention of the public having been largely drawn to the dangers of goats' milk. This has been helped by articles in the local press, and also through a pamphlet issued by the Public Health Department. Public interest in the matter was also roused by the strike of the goat-herds in the last fortnight of May, and we are informed that, during the closing months of the year, the attention of the public has also been called to the subject by the clergy.

2. *Age and Sex in Relation to Attack.*

The relation of age and sex to the occurrence of Mediterranean Fever is shown in the following table :—

Table II.

Years.	July 1, 1904—June 30, 1905.			July 1, 1905—June 30, 1906.		
	Males.	Females.	Total.	Males.	Females.	Total.
1— 5	6	11	17	13	6	19
6—10	18	23	41	25	24	49
11—15	23	48	71	34	35	69
16—20	54	51	105	62	49	111
21—25	56	50	106	71	46	117
26—30	49	40	89	45	53	98
31—35	31	28	59	31	29	60
36—40	26	20	46	29	30	59
41—45	21	16	37	20	30	50
46—50	16	21	37	19	18	37
51—55	14	15	29	18	16	34
56—60	7	16	23	20	15	35
61—65	8	5	13	12	7	19
66—70	9	4	13	4	2	6
71—75	—	—	—	5	2	7
76—80	1	—	1	1	1	2
81—85	—	—	—	1	1	2
86—90	1	—	1	—	—	—
Total ...	340	348	688	410	364	774

It will be observed from Table II that the disease may occur at any age, but that it was most common amongst persons between 10 and 30 years of age. A case was observed in the garrison during the year in which a baby was born at the time the mother was in hospital for the disease, and the infant had a temperature the curve of which corresponded almost exactly to that of the mother. Of 1462 notifications during the two years, 750 were males and 712 were females. The sexes would, therefore, appear to be about equally liable.

Case Mortality.—The case mortality for the 10 years 1896 to 1905 works out 9·5 per cent. as compared with 3·3 per cent. for the garrison. The returns of mortality to attack have shown progressively increasing figures during the last three years, as under :—

	Percentage of deaths to cases notified.
1902—03 (April 1—March 31) ...	8·1
1903—04	10·3
1904—05	13·2
1905—06	14·2

This increase is attributed by the Chief Government Medical Officer partly to cases of enteric fever having been reported as Mediterranean Fever, and partly to the return of cases as Mediterranean Fever which would have been formerly otherwise classified. He bases these assumptions on the fact of the general death rate showing decrease, and considers, therefore, that the increase observed in the death rates from fevers is chiefly a transfer of figures from other heads. The high case mortality indicates that a great many cases of Mediterranean Fever occur which are not notified. It is possible that many cases do not come under observation at all, and we have met with other instances in which notification has been delayed till the patient was at death's door. It must be remembered, too, that blood examinations are the exception and not the rule.

Irregular Prevalence of the Disease in Towns and Villages.—As pointed out in the military part of the report, there is great variation from year to year in the incidence of the disease in different barracks, so it will be observed from consideration of the figures in Dr. Johnstone's report, Part II, Commission Reports, p. 18, that similar variation of prevalence is also observed in the case of the civil communities. For example, the Floriana district shows more than the average number of notifications in 1896, 1899, 1904, and 1905, while the number was low in 1895 and 1898, and moderate in 1901 and 1902. Birchircara appears to have had an unusual prevalence of cases in 1899 as compared with other years. Notabile and Rabato had large prevalence in 1899, and we have already seen that there was a sharp outbreak of the disease in that year in the neighbouring Imtarfa Barracks. Zebbug had large prevalence in 1896, 1900, 1902, and 1905, but the notifications were much fewer in 1897 to 1899, 1901, and 1904. The differences are so very marked as to point to a factor which is liable to irregular variation, rather than to the presence of a condition or conditions of a more permanent kind, and it is thought that an infected milk hypothesis seems best to explain these variations.

Distribution of Mediterranean Fever in Malta.—Table III shows the distribution of the disease in the towns and villages during the two years from July 1, 1904, to June 30, 1906. For purposes of comparison, the first column gives the ratios per 10,000 of the population for the 10 years' period 1894 to 1903, which are taken from Dr. Johnstone's report.

This table shows:—

1. The very general character of the distribution of the disease amongst the towns and villages of Malta.

2. That while the prevalence in the rural areas remains fairly steady, there has been an increase in the notifications in the urban and suburban areas. It is impossible to say whether this increase is due to greater prevalence of Mediterranean Fever or to the greater

Table III.

Malta.	Average number of cases of Mediterranean Fever per year per 10,000 of population 1894—1903. *	From July 1, 1904, to June 30, 1905.			From July 1, 1905, to June 30, 1906.			Number of goats in each place at end of June, 1906.	Relation to population.
		Estimated population.	Cases of Mediterranean Fever.	Ratio per 10,000.	Estimated population.	Cases of Mediterranean Fever.	Ratio per 10,000.		
Urban drained area.									
Valletta	14·3	24,249	54	22·2	24,508	62	25·3	—	—
Floriana	45·7	6,140	37	60·2	6,241	70	112·1	—	—
Cospicua	16·6	13,130	18	13·7	13,271	16	12·0	47	—
Vittoriosa	22·9	8,008	25	31·2	8,106	42	51·8	274	—
Senglea	10·5	8,950	12	13·4	9,116	16	17·5	3	—
	18·8	60,477	146	24·1	61,242	206	33·6		
Suburban area, partially drained.									
Sliema and St. Julian	43·3	13,066	100	76·5	13,182	103	77·3	898	1—15
Hamrun	64·8	11,691	47	40·2	11,956	50	41·8	2,635	1— 4
Misida and Pieta	57·1	4,211	36	85·4	4,282	31	72·3	2,239	1— 2
Birchircara	54·2	9,101	66	72·5	9,219	56	60·7	1,454	1— 6
Curmi	6·0	9,145	11	12·0	9,307	20	21·4	553	1—17
Zabbar	38·6	6,260	18	28·7	6,358	12	18·8	1,024	1— 6
Tarxien and Paula	22·6	5,488	18	32·8	5,573	36	64·6	189	1— 5
	41·8	58,962	296	50·2	59,877	308	51·4		

Rural area.									
Notabile and Rabato	30 ·2	8,226	42	51 ·0	8,307	39	46 ·9	966	1— 8
Dingli	39 ·5	883	5	56 ·6	890	3	34 ·4	135	1— 6
Zebbug	53 ·5	5,952	15	25 ·2	6,037	33	54 ·6	552	1—11
Siggieui	26 ·9	3,525	5	14 ·1	3,569	5	14 ·0	300	1—12
Lia, Attard and Balzan...	73 ·0	4,910	87	177 ·2	4,954	31	62 ·5	723	1— 7
Naxaro	31 ·7	3,743	15	40 ·0	3,820	29	75 ·9	153	1—25
Musta	40 ·9	6,305	15	23 ·7	6,454	10	15 ·5	678	1— 9
Gargar......	22 ·9	1,476	5	33 ·8	1,503	6	39 ·9	239	1— 6
Mellieha	11 ·6	2,693	4	14 ·8	2,778	3	10 ·8	355	1— 8
Luca	7 ·8	3,971	13	32 ·7	3,980	14	35 ·1	442	1— 9
Zurrico	24 ·2	4,005	—	—	4,067	13	31 ·9	641	1— 6
Safi	31 ·4	405	—	—	414	—	—	136	1— 3
Crendi......	19 ·9	1,470	—	—	1,489	5	33 ·5	158	1— 9
Micabiba......	19 ·3	1,374	—	—	1,402	2	14 ·2	51	1—27
Chircop	22 ·6	728	1	13 ·7	742	—	—	157	1— 5
Zeitun	29 ·8	8,601	14	16 ·2	8,732	24	27 ·4	306	1—28
Axiak	22 ·1	1,688	1	5 ·9	1,713	4	23 ·3	442	1— 4
Gudia	26 ·3	1,245	2	16 ·0	1,261	1	7 ·9	360	1— 3
	33 ·4	61,200	224	36 ·6	62,112	222	35 ·7		
Public institutions......	—	—	22	—	—	25	—		
Not stated	—	—	—	—	—	13	—		
Totals for Malta...	32 ·0	180,639	688	38 ·0	183,231	774	42 ·2	17,110	1—10 ·7

* 'Reports of the Commission,' Part II, p. 18.

attention which has been paid to the disease during the last three years having caused more cases to be diagnosed and notified. It has to be remembered that blood examinations are not a routine proceeding in connection with civil cases, the diagnosis being mostly determined by the clinical features of the cases.

3. That the surburban districts have always shown a greater number of cases than the urban districts. Several points arise for consideration in this connection:

(*a*) Nearly all the places included under "suburban areas" are now drained, so that absence of drainage does not explain the heavier incidence.

(*b*) The disease does not show any marked preference for places having an indifferent sanitary reputation. During the two years July 1, 1904, to June 30, 1906, Sliema, which is a newly built suburb, well situated, with good streets and houses, good drainage, a satisfactory water supply, and containing the residences of a large proportion of well-to-do people, has been marked among the suburban districts by the highest prevalence of the disease. The sanitary conditions in Sliema are in marked contrast to the conditions obtaining in Misida, and yet the prevalence of the disease is about the same in the two places. Again, Birchircara and Curmi have frequently been contrasted, the former having a good reputation from a sanitary point of view, but a bad reputation as regards prevalence of Mediterranean Fever, while the conditions are the exact reverse in the case of Curmi. A possible explanation may be that there is a greater consumption of goats' milk in Birchircara than in Curmi. Table III shows that, with practically equal populations, there are nearly three times the number of goats in Birchircara than in Curmi; and, further, Curmi contains a much larger proportion of very poor people, and the poor are not large consumers of milk, as it is for them an expensive commodity.

(*c*) Although it often appears that density of population seems to be attended by marked incidence of Mediterranean Fever, yet this is far from being always the case. It will be observed (Table III) that Zebbug, which is one of the least densely populated places, displays more than average prevalence during the 10 years' period 1894 to 1903, and also in the second of the two years under consideration, although it was under the average in the first of these years. In the urban areas the same is observed. Floriana, which is much more open than Valletta and less densely peopled, shows more than three times the incidence of the latter for the decennial period and for the two years under special consideration. The Manderaggio, which is one of the poorest and most densely populated parts of Valletta, with a population of about 3000, and is also one of the worst parts from a sanitary standpoint, has only had five cases of Mediterranean Fever reported from it during the two years, two in 1904 and three in 1905.

3. *The Relation of Goats to the Incidence of the Disease.*

With a view to see whether any relation existed between the number of goats and the incidence of the disease in towns and villages, a special enumeration of the goats in Malta was made at the end of June, 1906. This was rendered possible by the fact that every goat owner has to register, at regular intervals, with the police, information regarding the number of goats he possesses. The figures are given in Table III, but we can draw no exact deductions of a general kind from the information so obtained. It is of interest to note, however, that a very large number of goats are kept in the suburban districts, which, as already pointed out, are also marked by the greatest incidence of Mediterranean Fever. It is from these suburban herds that the milk supplies of Valletta, Floriana, Sliema, and the three cities are chiefly obtained. Hamrun, Birchircara, and Misida provide the supplies for Valletta, Floriana, and Sliema, while the Zabbar, Tarxien, and Paula goats supply Cospicua, Vittoriosa, and Senglea.

Exportation of Goats from Malta.—A large number of goats are exported from Malta each year, chiefly to Sicily and North Africa. In the two years from July 1, 1904, to June 30, 1906, the numbers exported were 1911 goats, 20 kids, and seven billy goats. In this number are included the goats shipped in the s.s. "Joshua Nicholson," which, as related elsewhere, led to an outbreak of Mediterranean Fever on that ship and to the occurrence of cases in the United States. It is evident, therefore, that the exportation of goats is attended by the danger of the spread of the disease in the places to which the animals are consigned. As already mentioned in the military part of this report, Horrocks has pointed out that in 1883, when Mediterranean Fever was prevalent in Gibraltar, practically all the goats on the Rock were Maltese, and that regular shipments of goats from Malta to Gibraltar took place at that time. Shortly after 1883 there was an increase in the cost of shipment, which led to the stoppage of the importation of goats from Malta on a large scale and, coincident with this, the disease has practically disappeared from Gibraltar.

Milk in Relation to Incidence among the Civil Population.—The milk supply of the civil population is goats' milk, and it is generally used unboiled. In some cases the milk is obtained regularly from the same goat-herd; in others, and this is very common, the milk is bought from any passing herd, while others again keep one or sometimes two goats of their own. We have been informed that many poor people do not use milk at all except when it is required for cases of sickness.

During the last two years, special enquiries were made by the sanitary inspectors with regard to the source of the milk used by patients notified as suffering from Mediterranean Fever, and the

results are as follows. Of the 1462 cases notified, no particulars could be obtained in 68 instances. In the remaining 1394 cases, goats' milk was used by 1318 of the patients, condensed milk in five instances, while there is a history of no milk in any form in the remaining 71 cases.

Table III shows that Lia, Attard and Balzan usually exhibit a heavy prevalence of the disease. Two hundred and three of the goats at Lia and Balzan were examined in 1905, and 31 were found to be infected. The Chief Government Medical Officer, Dr. Caruana Scicluna, has provided a good piece of negative evidence in connection with the Institute of the Good Shepherd at Balzan. He states that there has not been a single case of fever amongst the 200 inmates of this institution for many years past. The goats supplying the milk are the property of the Institute, and when examined they have been found to be uninfected.

Further details with regard to goats' milk as a factor in the causation of Mediterranean Fever amongst the civil population are given in the paper contributed by Dr. A. Critien, of the Public Health Department, Malta, p. 235.

Control of Goats and of the Milk Supply.—It follows, from a consideration of the dangers of infected goats' milk, that the most imperative need is the regulation of the goat traffic and proper control of the milk supply. The goats should be kept outside the towns, and suitable arrangements made for bringing the milk in to be sold. In Malta it is urged that the poor people prefer to have the goats brought to their door and there milked, because they can then see what they are getting, and there is less chance of adulteration. But surely this is a prejudice that can be overcome. In no other civilised community is the source of the supply brought to the consumer's door to be milked, and there is no greater likelihood of adulterated milk being vended in Malta than exists in every other place of importance in the world. Everyone who is familiar with the streets of Valletta is also familiar with the smell of these streets. The objectionable smells are entirely due to the perambulation of the streets by herds of goats. In every gutter are to be seen collections of goats' urine, and these and the goats themselves are the causes of the foul odours. A great object-lesson was furnished to the inhabitants of Valletta during the fortnight that the goat-herds' strike lasted. There were no goats in the town during that period, the streets were clean, and the bad smells disappeared completely. The extraordinary improvement in the state of the streets was the subject of common remark at the time. As soon as the goats returned, the smells became as bad as ever. There can be no doubt about the fact that if the goats were excluded from the streets, Valletta would be as clean and pleasant as any well-run town in Europe. Until the goats are removed the condition of the

streets must continue to be a reproach, and Valletta must be regarded as being content with a sanitary standard which is far below what it might be.

Improved Sanitation.—Otherwise, considerable improvements have been made during the last two years. Young men are being sent to England to be trained in the duties of sanitary inspectors. Very fine public urinals have been erected in different parts of Valletta. In company with the Director of Public Works, we went over the entire drainage system, including the pumping arrangements at Sliema, the flushing tank at Lower St. Elmo, and with Dr. Zammit we visited the sewage outfall to the sea beyond Ricasoli. We also saw the new Shone installation for dealing with the low-level drainage of the low-lying parts surrounding the upper end of the Grand Harbour and along its Valletta side. The work in connection with this new system was almost completed, but was not yet in use when we left Malta at the end of September. There is another large project in course of construction, which has for its object the flushing of the entire sewerage system of Malta with sea water, including outlying towns and villages as well as Valletta and the three Cities. The main supply tank has been excavated, and to this sea water will be pumped, and from it the flushing water will be distributed by gravitation. It will be a considerable time before the pumping plant is installed, and it will necessarily take time to connect up to the various lines of drainage. When completed, it will be a sanitary advance of great importance. If, at the same time, it were possible to combine with it a free supply of water for flushing from the houses through the house drains into the main drains, there would be little fault to find with the sewerage of Malta, although there would be still room for great improvement in regard to house fitments and connections.

4. *Goats' Milk as a Factor in the Causation of Mediterranean Fever amongst the Civil Population.*

By Dr. A. Critien, Public Health Department, Malta.

The recovery of *Micrococcus melitensis* from goats' milk has very naturally directed the epidemiologist's activity to a new line of investigation which, if attended with positive results, must put Mediterranean Fever in a great measure within the reach of preventive medicine. The facts collected and the work done in this direction, during the last few months, have established that infected milk, though not the only channel, plays a very important part in the transmission of the disease. The following few observations, abstracted from the results of personal inquiries into 245 notified cases of Mediterranean Fever, are therefore intended only as a small contribution towards the study of this question.

The milk used in Malta is goats' milk; the number of milch cows in

the island is too small to be taken into consideration. The consumption of milk has during the last few years been steadily increasing, both in town and in the country; and though in the villages it is far from rare to find persons who absolutely refuse to drink milk, in the towns and suburbs such perhaps are only exceptionally met with. Milk is not boiled; this precaution has hitherto been considered superfluous, because the Maltese goat has never been known to suffer naturally from tuberculosis; bovine tuberculosis, it must be remembered, has been mainly responsible for the continental routine of milk sterilisation by boiling.

Milk is generally drunk with tea or coffee, the proportion of milk varying with the means of the particular individual. Weak digestive organs, the result of higher civilisation and of a harder struggle for life, have for obvious reasons contributed to increase the consumption of fresh milk, an item, moreover, which enters largely into the diet of the younger members of the population. Some of the foregoing statements are supported by figures shown in Table "A," from which we see that the number of goats in Malta has doubled during the last 15 years; but the population has not increased in the same proportion; whilst in 1891 there was one goat for every 17 persons, now there is one for every 10.

Table A.—Malta.

Year.	Civil population.	Number of milch goats.	Proportion of goats to persons.
1891......	146,484	8,724	1 in 17
1901......	164,952	10,944	1 in 15
1906......	183,231	17,488	1 in 10

Out of 511 cases of fever notified as Mediterranean Fever from the beginning of January to the middle of August, 1906, I have been able to inspect premises where 245 cases had occurred and to interview either the patients themselves or some relative.

The information collected with regard to the use of milk may be tabulated as follows:—

Table B.

No milk.	Condensed milk.	Cows' milk, boiled.	Goats' milk, boiled.	Goats' milk, unboiled, by itself.	Goats' milk, unboiled, with tea.	Goats' milk, how used not ascertained.
50	5	3	5	43	103	36
58			187			

The proportion of fever patients who are milk-users to non-milk or other milk-users may, therefore, be calculated as 3 to 1. As my investigation was not limited to fever cases in the towns, but extended to cases in the villages and suburbs, this proportion may be regarded to obtain generally amongst all persons suffering from the fever in Malta.

Out of 315 cases of fever notified from August to December, 1905, 26 occurred in premises where one or more goats were kept and, with few exceptions, had supplied milk to the patients before illness. Out of the 511 cases notified between January and August, 1906, 67 occurred under similar circumstances, 30 occurring amongst herdsmen. The 67 cases were distributed as follows:—

		Cases.
50 dwellings with	1 case in each.........	50
3 ,,	3 cases in each	9
2 ,,	4 ,, ...	8
	Total	67

Of the 26 cases in the August to December, 1905, series, nine were amongst herdsmen. Ten cases notified from the village of Lia during that period may be thus classified:—

Three in one herdsman's family.

Four in households supplied with milk by this herdsman.

Three milk supply not ascertained.

Altogether seven members of this herdsman's family were down with fever during 1905.

Some of the information collected about 25 of the 67 cases mentioned above is given in Table "C." Those instances only have have been recorded in which the goat or goats had been penned in the same house or compound where the cases occurred.

In connection with 17 of these, the milk supply was examined bacteriologically. I regret that such a research, owing to stress of other work, could not be extended to all the cases. Three of these 17 cases occurred in the same house, so that the number of instances in which milk supply was found to react to Zammit's test may be put down as 7 out of 15, and the *Micrococcus melitensis* was isolated in 3.

The milk supply was examined in connection with another series of 25 cases which had been regularly supplied, previously to their illness, with milk by one or more milk herds. Results are given in Table "D." This is by no means a selected series, although a short one. The difficulty met with in trying to identify the milk supply in the majority of cases personally investigated has so far frustrated my best efforts. As the milk is hawked in the streets, many persons get their milk from the first milkman who happens to be about at the time milk

Table C.—Twenty-five Cases of Mediterranean Fever in Premises where one or more Goats were kept before Illness.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Goats in premises.	Milk.	Patient's reaction.	Examination of milk.
P. A.	M.	3	Yes	Yes	Herd	Goats'	+	Not examined.
M. P.	F.	30	,,	,,	,,	,,	+	,,
P. G.	F.	37	,,	,,	2 goats	,,	+	,,
G. F.	M.	56	,,	?	1 goat	,,	+	Examined and plated twice; reacted within 2 hours; no *Micrococcus melitensis* recovered
G. F.	F.	24	,,	Yes	,,	Not used	+	Examined twice, no reaction
C. D.	M.	33	,,	,,	,,	Goats'	Tested once	Examined once, no reaction
C. M.	F.	35	,,	,,	Herd	Not used	,,	Not examined
J. C.	M.	21	,,	?	2 goats	Goats' with tea	+	Examined once; 1 reacted within 2 hours; plated; no *Micrococcus melitensis* recovered
G. G.	M.	50	,,	Yes	Herd	Not used	+	Of 6 goats, 1 secretes *Micrococcus melitensis*
G. C.	F.	13	,,	,,	1 goat	Goats' with coffee	+	Examined once; no reaction
G. P.	F.	57	,,	No	2 goats	,,	+	Examined three times; 1 reacted within 2 hours; no *Micrococcus melitensis* recovered

In same house—								
N. B.	F.	45	,,	Yes	Herd	Goats' by itself	?	Not examined
C. B.	F.	15	,,	,,	,,	Fresh	?	,,
G. E.	M.	36	,,	,,	1 goat	Goats'	?	Examined twice; no reaction
In same house—								
A. C.	M.	39	,,	,,	,,	,,	?	Examined once; reacted within 2 hours; no *Micrococcus melitensis* recovered
M. C.	F.	38	,,	,,	,,	,,	+	
S. C.	M.	18	,,	,,	1 sheep	,,	?	
M. B.	F.	60	,,	,,	1 goat, 1 sheep	Goats' by itself, fresh	+	Examined once; no reaction within 2 hours
R. V.	F.	22	,,	,,	1 goat	Not used	+	,, ,,
V. S.	F.	62	,,	,,	Herd	Goats', fresh by itself	+	3 goats out of 34 reacted; 1 yielded *Micrococcus melitensis*
C. C.	M.	20	,,	No	,,	,,	+	10 goats out of 18 examined; no reaction
S. B.	M.	48	,,	Yes	1 goat	Not used	+	Examined twice: reacted within 2 hours; *Micrococcus melitensis* recovered
C. M.	M.	18	,,	,,	Herd	Goats'	+	Not used
S. C.	M.	36	,,	,,	2 goats	Goats' with coffee	+	Examined twice; no reaction
N. M.	M.	64	,,	,	1 goat, 4 sheep	,,	+	Not examined

Table D.—Bacteriological Examination of Milk Supply in connection with 25 Cases of Mediterranean Fever.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Milk used.	Patient's reaction.	Examination of milk supply.
N. C.	M.	20	Yes	Yes	Goats' unboiled	+	
C. F.	F.	15	„	„	„	?	
M. A. B.	F.	56	Second attack	No	„	+	Common milk supply
In same house—							
G. B.	M.	½	Yes	Yes	„	+	
C. B.	F.	?	„	No	„	+	36 goats' milk examined; 8 reacted within 2 hours; *Micrococcus melitensis* recovered from 2
C. P.	F.	15	„	Yes	Goats' unboiled with tea	+	
P. B.	M.	29	„	„	Goats' unboiled by itself	+	
A. G.	F.	25	„	„	„	+	
V. B.	M.	51	Second attack	No	Goats' unboiled with tea	+	Common milk supply; 6 goats' milk examined; *Micrococcus melitensis* recovered from 2
E. C.	F.	38	Yes	Yes	Goats' unboiled by itself	+	
G. Z.	F.	29	„	„	„	+	9 goats' milk examined; 2 reacted within 2 hours; *Micrococcus melitensis* not recovered
M. F.	F.	41	„	„	„	+	24 goats' milk examined; *Micrococcus melitensis* recovered from 4; 6 goats' milk examined; *Micrococcus melitensis* recovered from 1
C. Z.	F.	40	„	„	„	+	1 goat's milk examined; no reaction
C. F.	F.	40	„	„	„	+	13 goats' milk examined; *Micrococcus melitensis* recovered from 6
G. C.	F.	13	„	„	„	+	15 goats' milk examined; none reacted

S. F.	M.	43	"	"	"	?	6 goats' milk examined; *Micrococcus melitensis* recovered from 1
C. B.	M.	21	"	"	"	+	2 goats' milk examined; no reaction
In same house—							
A. C.	F.	25	Yes	Yes	"	+	7 goats' milk examined; 2 reacted; *Micrococcus melitensis* recovered from 2
M. C.	F.	18	"	"	"	+	
E. C.	M.	26	"	"	Goats' unboiled with tea	+	
L. C.	F.	15	"	"	"	+	
W. C.	M.	28	"	"	"	+	
In same house—							
N. G.	M.	18	"	"	Goats' unboiled	+	20 goats' milk examined; 1 reacted; *Micrococcus melitensis* not recovered
N. S.	M.	20	"	"	"	+	
N. O. R.	M.	20	"	"	"	+	

Table E.—Seven Cases of Mediterranean Fever and Result of Bacteriological Examination of Milk Supply in connection with same.

Initials of patients.	Sex.	Age.	First attack.	First case in premises.	Milk used.	Patient's reaction.	Examination of milk supply.
G. M.	M.	43	Yes	No	Goat's	?	1 goat owned by patient. No reaction
A. V.	F.	$5\frac{1}{2}$	"	Yes	"	?	1 goat owned by patient. No reaction. Other goats had been supplying milk. Not examined
M. P.	F.	40	"	No	"	+	2 goats owned by patients. No reaction
G. D.	M.	?	"	Yes	"	?	
F. V.	F.	54	"	"	"	+	2 goats, 1 reacted within 2 hours; *Micrococcus melitensis* not recovered
G. V.	M.	17	"	No	"	?	
C. C.	F.	45	"	Yes	"	+	1 goat owned by patient. No reaction

is required. Many again, who get it regularly from the same man, cannot remember anything more than his Christian name. Others are very reticent, because they cannot understand why the milk they have been consuming for months without any ill effects should be suspected of being the cause of Mediterranean Fever.

Four groups of cases shown in Table "D" had a common milk supply. Two cases in the first group occurred in the same dwelling; the third group—five cases—had also a common residence, and the same was the case as regards the fourth group. In six instances the milk supply was found to be actually infected, viz., one or more goats were at the time excreting *Micrococcus melitensis* with their milk; in two instances one or more goats gave Zammit's reaction, but did not yield *Micrococcus melitensis* on the particular day they were examined, and in three instances none of the goats reacted. Six cases out of the first series of eight having a common milk supply occurred in the same street.

The milk supply of another series of seven cases, not included in the 245 investigated by me, was also examined. In one instance Zammit's reaction was obtained (Table "E").

A striking contrast to the heavy incidence of Mediterranean Fever among the general population is offered by the absence of the disease in communities that do not use milk. The Civil Prison, with its average daily population of about 185 persons of different sexes and ages, is an example. No milk under any form is allowed to the prisoners unless they are on the sick list. The average daily sick for the year 1905—6 was 24·9. Under these circumstances, although the prison may be said to form part of Paola, a village which is by no means free from Mediterranean Fever, only one case has been recorded during many years. This case reported sick on May 8, 1906; his blood, which was negative on the 16th of the same month, reacted well in 1 in 40 against *Micrococcus melitensis* on June 6 when he first sickened. Less than a month had elapsed since his commitment, and if he had not been detained some time at Gozo, the sister island, before his transfer to the Malta gaol, one would have been quite justified in doubting whether the disease had been contracted in prison. Another case, notified from the same prison in 1903, must have been infected when at large, because he had only been in prison three days when he developed Mediterranean Fever. So that, except for the case previously mentioned, the disease has been unknown among this community. Both the present medical officer and his predecessor agree in stating that during the time they have had medical charge of the prisoners—a period of nine years—no other cases of Mediterranean Fever have come under their observation. The only channel of infection that has been inoperative all through these years is goats' milk. Dust contaminated with infected urine must have been blown many a time from the streets of Paola into the prisoners' cells,

and mosquitoes, another suspected carrier of infection, cannot have found it difficult to fly from the village houses to the prison compound. One cannot, therefore, help connecting the absence of Mediterranean Fever with the absence of milk from the prisoners' dietary.

Human milk, like goats' milk, agglutinates the specific micrococcus, if obtained from Mediterranean Fever patients. The highest dilution attended with positive results has been, in one of my cases, 1 in 150 within half an hour. It does not appear that human milk is likely to react in the same high dilutions as some blood sera. Although I have not been successful in isolating *Micrococcus melitensis* from human milk, its transmission from mother to child, through this channel, has been actually demonstrated by Major McNaught, R.A.M.C., so that the danger of the disease being thus conveyed must not be lost sight of.

The quantity of milk obtained from three out of my seven cases was very small (one to two drops), and no plating was, therefore, attempted; the plates prepared from the rest were so overgrown with other bacteria that the identification of *Micrococcus melitensis* was rendered impossible.

A few notes about the cases will not, I hope, be found superfluous.

1. M. P., aged 30. Baby 4 months old. Fever began a few days after confinement. Milk thin and serous; it reacts within half an hour in a dilution of 1 in 20. Blood reacts well. Specimen of baby's blood could not be obtained.

2. E. C., aged 30. Baby 3 months old. Fever began before confinement. Breast almost dry, one or two drops of very thin fluid obtained: it reacts within half an hour up to 1 in 80. Blood reacts 1 in 40 at once; higher dilutions not tried.

3. G. F., aged 24. Confined three weeks before; baby weaned. Breast drying up. Few drops of curdy fluid obtained; it reacts up to 1 in 40 at once. Blood reacts well in same dilution; higher dilutions not tried.

4. C. Z., aged 40. Onset of fever one month after childbirth; nursing baby 4 months old. Milk has diminished in quantity and is very thin. It reacts only up to 1 in 20 in half an hour. Mother's blood reacts well in 1 in 40. Baby's blood does not react; only 1 in 10 tried. Milk plated; no *Micrococcus melitensis* recovered.

5. C. F., aged 21. Fever started one month before confinement. Baby was given out to nurse, and is now 2 months old. Milk reacts readily up to 1 in 150 in half an hour. Blood reacts well 1 in 40. A few drops of milk plated. No *Micrococcus melitensis* recovered.

6. P. G., aged 24. She is nursing baby 9 months old. Fever began three months after confinement. Blood reacts well. Milk positive up to 1 in 20 in half an hour. Plated; no *Micrococcus melitensis* recovered. Specimen of blood from baby was refused.

7. C. B., aged 22. Fever began a fortnight after confinement. Baby is now 4 months old. Milk reacts only 1 in 5 in half an hour. Blood reacts at once in 1 in 40. Specimen of baby's blood was refused. Milk plated; no *Micrococcus melitensis* recovered.

General Summary.

By Major T. McCulloch, M.B., Major J. C. Weir, M.B., Royal Army Medical Corps; and Staff-Surgeon F. A. H. Clayton, M.D., Royal Navy.

i. The incubation period.
ii. A critical examination of the naval, military, and civil observations.
iii. Recommendations.

i. The Incubation Period.

In the previous epidemiological reports it has been customary to discuss the question of incubation period at the commencement, in order to fix working data. This course has not been followed on the present occasion, as in the investigation of cases it was found that to keep rigidly to any fixed period was often impossible. In a very considerable proportion of the individual cases investigated there has been a sort of preliminary canter of a few days' pyrexia, but without agglutination reaction, followed later by a definite appearance of Mediterranean Fever. In many other cases the patients have felt vaguely ill for months. Again, many patients, admitted to hospital for other illness, have exhibited towards the latter part of their stay a few days of febrile and other symptoms, with no very obvious cause, and shortly after leaving hospital they developed Mediterranean Fever. Similarly, many of those who developed the disease while still resident showed the same history of preceding slight febrile attack. All this points to the very insidious nature of the onset of this disease and to the difficulties encountered in fixing the limits of an incubation period, and in saying whether an outburst of symptoms is, or is not, the first manifestation of the disease. Nothing would have answered our purpose better than to have been in a position to apply a definite period of incubation to the date of onset of symptoms, and so fix with some degree of certainty the time within which infection must necessarily have occurred. Much suggestive information on this point was obtained in the course of our work and from the study of statistical data, particularly data relating to the interval between residence in hospital for other illness and onset of symptoms of Mediterranean Fever, and in regard to the onset of illness occurring in cases after the men had left Malta.

Accidental or purposive laboratory inoculations appear to show an incubation period varying between five and 16 days. Dr. Johnstone gives his views with regard to the matter in the following words:—"It may, however, be provisionally stated that the data available tend in some degree to suggest that the period of incubation of Mediterranean

Fever ranges about a period of 14 days." Lieut.-Colonel Davies considers that there is a sufficient agreement in the results of animal experiments to lead to the supposition, which is on other grounds reasonable, that with infection by inoculation the incubation period is shorter than by ingestion into the alimentary canal; and this appears to be borne out by the results of the feeding experiments this year, no monkey so experimented upon having had an incubation period of less than 12 days. In connection with this subject, it is of interest to note that, this year, when the infected food was limited to one day's feeding, the appearance of the agglutination reaction varied from 12 to 21 days, as opposed to 14 to 76 days obtained last year as the results of feeding experiments in which infected food was given over many days. It has been suggested by the laboratory members of this year's working party that a probable explanation of the delay in the appearance of the agglutination reaction observed in last year's experiments would be that repeated doses of *Micrococcus melitensis* produced a negative phase, which lasted until the cessation of feeding or an absence of the micrococcus permitted the formation of the specific agglutinins. Viewed from the epidemiological standpoint, the same reasoning may possibly explain the very late appearance of the agglutination reaction in certain typical and atypical cases of the disease, in which milk has been ingested over considerable periods, and who, therefore, may have been receiving repeated quantities of *Micrococcus melitensis.* We associate ourselves with the view expressed by Lieut.-Colonel Davies, in Part IV of the Commission Reports, to the effect that the laboratory limits in all probability require to be considerably extended when the question of human infection in the ordinary way, or ways, has to be dealt with. To this certain of the facts, already recorded, would seem to point, and, in fact, we quote well authenticated cases where the interval between possible exposure to infection and the onset of definite symptoms runs even to months.

The cases which present difficulty in this direction fall under three categories :—

1. Cases presenting suggestive symptoms, but where agglutination is long delayed. These are so comparatively common that further discussion is unnecessary.

2. Cases presenting well marked agglutination reaction, without symptoms and without history of previous illness. Shaw's observations have already shown that the Maltese are sometimes definitely infected by *Micrococcus melitensis* without the slightest apparent effect on their general health. During the blood examinations of healthy English contacts this year (*vide* p. 216), instances were from time to time met with which were strongly suggestive of the occurrence of this condition in their case also. The following are examples :—

Two boys, belonging to the garrison, whose father and mother were

both admitted for Mediterranean Fever in the summer of 1906, gave good serum reactions on repeated examinations. There was no previous history of fever, nor have either of these boys suffered from even a transient illness subsequently. In many instances, during the routine examinations of samples of blood from soldiers who had been in "contact" with a case of the disease, a positive reaction was obtained, and the men were kept under observation, but no departure from their normal state of health was observed (see also examination of bloods of contacts, p. 216).

3. *Latent Infections.*—These are cases in which infection has occurred, but in some of which there is prolonged delay in the appearance of any illness, while in others there are only vague symptoms, insufficient to incapacitate the affected individual. In such latent infections some lowering of vitality, the result of special stress or occurrence of other illness, may determine the onset. The following are illustrative cases :—

(1.) Two of the hospital staff at Bighi were found by Staff-Surgeon Whiteside to react to *Micrococcus melitensis*, one as high as 1 in 300, without ever having been on the sick list, although in both cases there was a history of malaise during the previous summer, months before the examination. The man showing the reaction in lower dilutions subsequently developed an attack of Mediterranean Fever, the other did not.

(2.) W. H. W., ordinary seaman, of the "Diana," was in Bighi Hospital from May 31 to July 12, 1905, with a fractured tibia. After July 27 he suffered from occasional headaches. His ship left Malta a week after his discharge to her from hospital, and remained either at Candia or Suda Bay, with the exception of six days at Phalerum Bay, until November 15, when she returned to Malta and stayed until December 18. During September, while engaged in stokers' training class, very trying work indeed, the patient had felt unwell, but did not go on the list or make any complaint. The ship left Malta again on December 18 for Port Said, where she remained until January 18, and then proceeded *viâ* Suez and Port Sudan to Akaba in connection with the Turkish frontier dispute, arriving there on February 18 and remaining till May 22, a period of three months. Here she lay off a practically uninhabited coast, with which there was no communication, and her only intercourse with the outside world was through a weekly steamer which brought provisions. On May 2, 72 days after arrival here, the patient was noted to be looking ill, and although he made no complaint he was placed on the list, and was found to have pyrexia and to give a good reaction with *Micrococcus melitensis*, which was verified in the Commission laboratory on his arrival in Malta on June 1. He had not been ashore at all since general leave in Malta in December, 1905, and no cases had occurred in the ship since September,

1905. There were practically no mosquitoes at Akaba, and no inhabitants anywhere near. On the ship's return to Malta, all her Maltese, numbering 13, were examined, and one was found to react well, but his urine was plated out with negative result. The opinion of the medical officer of the ship was that the case was an ambulatory one, which had been contracted in Bighi in July, 1905, and although one cannot absolutely exclude the possibility of ship infection, this seems the most probable explanation in view of the history.

Bruce states that cases have occurred in as short a period as six days after arrival in Malta. Johnstone quotes cases occurring eight and 11 days after arrival. In the course of the present enquiry the following additional cases have been noticed during our examination of army records :—

	Age.	Total service.	Service in Malta.
		years.	
1. Private D., 3rd K.O. Yorkshire Light Infantry ...	42	13	1 week
2. Private J., 1st Royal Garrison Regiment............	40	6/12	1 ,,
3. Drummer D., 5th Royal Munster Fusiliers	12	1	16 days
4. Private O., 2nd Loyal N. Lancashire Regiment ...	19	11/12	2 weeks
5. Private P., 3rd Royal Garrison Regiment	34	3/12	2 ,,
6. Private T., 3rd Royal Garrison Regiment	35	7/12	3 ,,
7. Gunner J., 63rd Company, Royal Garrison Artillery	19	1	2 ,,
8. Private McG., 1st Royal Dublin Fusiliers	—	—	11 days

Case 2 was admitted for Mediterranean Fever, but gave a negative reaction up to 24 days after admission. Case 5 was admitted for fever, but gave a negative reaction 13 days after admission and no positive reaction is recorded until over two months later. Case 7 gave a positive reaction 10 days after admission. The other cases gave early reactions.

The longest interval between apparent exposure to infection and appearance of symptoms that came under Johnstone's observation, was the case recorded by Bassett-Smith, in which the interval was apparently two months. In the following case the possibilities of exposure to infection after the man had left Malta were practically nil, and the interval, as will be seen, was over three months.

R. H., stoker, H.M.S. "Sentinel," was a patient in Bighi Hospital from January 29 to February 28, 1906, with syphilis. It was a mild case of syphilis, with chancre and secondary symptoms. No record of temperature. During his stay there he had no symptoms in any way suggestive of Mediterranean Fever, nor was there any previous fever history. He had three pints of milk daily for 26 days, and it was stated that he was quite well on return to his ship. H.M.S. "Sentinel" left Malta on March 2. On the passage home, the ship arrived at Gibraltar on the 5th and remained

there till March 20, arriving at Plymouth on the 25th. This man did not go ashore either at Malta or Gibraltar. He had a feverish attack, starting on June 6, with pains in joints and swelling of knees and wrists, but he had recovered by June 16 and returned to duty. During the manœuvres in June the ship called again at Gibraltar, but only coaled, and sailed at once, and was not again within the limits o the Mediterranean station. This was on June 30, after the patient had had the feverish attack referred to. A recurrence of symptoms occurred on July 5, when he was sent to Plymouth Hospital, where he gave a positive agglutination reaction up to 1 in 500, and he died on July 18.

The following cases, bearing on the same point, were kindly provided from the records of the home naval hospitals:

Mr. C. F. returned from the China station, probably calling at Malta, and two months after return was attacked by illness, which, on admission to Plymouth Hospital in August, 1905, proved to be Mediterranean Fever.

Commander W. F. B. left Malta at the end of March, and was placed on the sick list on May 11, but he first began to feel ill about the middle of April.

Mr. B. B. called at Malta from June 15 to 20, on his way home from China in the "Andromeda." The onset of his attack, which was stated to be the first attack, and to be acute, was on August 20. His blood reacted at Haslar up to 1 in 40.

W. H. had returned from the Mediterranean six months previous to the onset of his attack on November 16, 1905, at Chatham.

All these cases are reported to be first attacks.

The following cases were obtained from military records :—

The information from Egypt was kindly furnished by the Principal Medical Officer of that command. We are indebted to Lieut.-Colonel J. B. Wilson, R.A.M.C., for the particulars regarding the cases occurring in Alexandria, in 1905 and 1906, amongst men of regiments which had recently arrived from Malta. Lieut.-Colonel Wilson had made special notes in these cases for the purpose of throwing light on the incubation period, and he considers it very improbable that the disease in any of the cases could have been contracted in Alexandria.

It may be urged that the sequence of cases indicates the possibility of contact as a factor, and this possibility has already been mentioned (p. 148) in connection with the cases which occurred in 1905, at Cairo, amongst the men of the 1st Battalion King's Royal Rifles, some months after the arrival of the regiment there from Malta. As in the Cairo cases, so in the Alexandria cases, the disease only appeared in men who had previously served in Malta. Against the contact view in the Alexandria cases it may be further stated, however, that the distribution was a scattered one, involving five companies out of eight, and the officers' mess, in the 18 cases belonging to the Dublin Fusiliers; and four companies and the officers' mess in the six cases belonging to the Worcestershire Regiment.

It may be noted too that, as Cases 1 and 2 in the Dublin Fusiliers list were in hospital before the arrival of any of the other men

attacked in Alexandria, there is little possibility that they were the source of infection for the cases that occurred subsequently.

Number.	Date of arrival in Alexandria.	Date of onset of symptoms.	Interval between leaving Malta and onset.	Remarks.
1st Royal Dublin Fusiliers—			days.	
1	10/10/05	20/10/05	14	
2		23/10/05	17	
3	19/11/05	4/12/05	20	
4	,,	10/12/05	26	
5	,,	,,	,,	
6	,,	11/12/05	27	
7	,,	20/12/05	36	
8	,,	22/12/05	38	
9	,,	23/12/05	39	
10	,,	30/12/05	46	
11	,,	6/ 1/06	53	
12	,,	7/ 1/06	54	
13	,,	26/ 1/06	72	
14	,,	31/ 1/06	77	
15	,,	12/ 2/06	91	
16	,,	Unknown	—	Admitted to sick list 60 days after leaving Malta
17	,,	,,	—	Admitted to hospital 83 days after leaving Malta
18	,,	22/11/05	8	First admitted for rheumatic fever, but this was probably an error. No blood examination was made until February 12, 1906, when he was again admitted and Mediterranean fever was diagnosed
4th Worcestershire Regiment—				
19	11/ 5/06	14/ 5/06	7	
20	,,	16/ 5/06	9	
21	,,	17/ 5/06	10	
22	,,	18/ 5/06	11	
23	,,	21/ 5/06	14	
24	,,	8/ 6/06	28	

It will be further observed that there was a constant sequence of cases in the Dublin Fusiliers, up to 91 days after their departure from Malta. Then, notwithstanding the advent of the hot weather, the disease in this regiment entirely ceased.

Stronger still is the fact, that there followed an entire absence of Mediterranean Fever from the garrison of Alexandria until the arrival

of the Worcestershire Regiment from Malta, when the disease again made its appearance, but only among the men of that particular regiment.

For the following cases we are indebted to Lieut.-Colonel Jennings, Royal Army Medical Corps, Malta.

A party of two ladies and a maid, travelling in the Mediterranean, were on a steamer that went ashore at Malta on April 21, 1906, and they left Malta for England on May 7. One of the ladies developed Mediterranean Fever on May 9, and the attack proved one of great severity. In this case the incubation period may have been anything up to 18 days. The second lady, who was companion to the first, was attacked eight days later, her illness dating from May 17, with an incubation period, therefore, of any time up to 26 days. The maid, on arrival in England, went to her home for a holiday on May 18, and she was attacked on June 6, or just about a month after leaving Malta. The doctor of the steamer, who was in Malta during the same period, was also attacked, and the onset of his illness dates from May 25; and his attack was also one of great severity. The diagnosis in the first and fourth of these cases was supported by positive agglutination reactions.

ii. A Critical Examination of the Naval, Military and Civil Observations.

The important facts with regard to the ways in which the specific micrococci find their way out of the bodies of infected men, or of infected animals, may be summed up as follows. Examinations of the breath, saliva, sweat and scrapings from the skin have yielded negative results. The bowel discharges are still in the doubtful category. The micrococci have been recovered from the blood, and also from blood ingested by biting insects. The main paths, however, are in milk and in the urine, and of these the first is by far the more important.

The possible paths of infection which have been advanced in discussions relating to the etiology of Mediterranean Fever include food stuffs, and particularly milk and its products, contact, mosquitoes or other biting insects, infected dust, latrine and drain infection, water, etc.

Milk.—The main facts which have been established with regard to the infectivity of milk are:—

1. That a very large percentage of the goats in Malta are infected.

2. That the milk of a large proportion of the infected goats has been found to contain the specific micro-organism, and often in enormous numbers.

3. That the quantities present show great variations from time to

time, and no obvious relation has been observed to temperature or to season of the year, either with regard to abnormal presence of *Micrococcus melitensis*, or to their disappearance from an infected milk.

4. That monkeys and other animals fed on naturally infected milk have contracted the disease as a result.

5. That, in addition to the evidence relating to Malta, the disease has been found to be associated with goats, both in India and the Orange River Colony; and in India the specific organism has been recovered from the milk.

The evidence which we have collected with regard to the part played by the goat, and by milk obtained from it, may be divided into suggestive and direct evidence.

(i.) *Suggestive Evidence.*—1. Mediterranean Fever shows marked variations in incidence in the various barracks, that is to say, there is little or no evidence of persistent or constantly recurring place infection, confined year after year to the same barracks or to the same parts of barracks, but the same cannot be said of hospitals.

2. Although, taken collectively, there is special prevalence of the disease in the hot weather months, it is found on examining the figures for the individual years of the series, 1899 to 1905, that considerable variations occur as to the months that show the highest prevalence. Seasonal prevalence would appear to be an argument against the milk hypothesis, but possible explanations may be, that if milk containing the micrococcus is left standing about, the conditions are more favourable for multiplication of the organism in the hot than in the cold weather; also that cream or milk with fruit, or in ice creams, etc., are more largely consumed in the hot months; finally, the debilitating influences of the hot season may reasonably be regarded as likely to increase individual susceptibility.

The statements made in 1 and 2 apply also to the occurrence of cases amongst those resident, as patients or otherwise, in the Royal Naval Hospital, Bighi.

3. Every year there is very widespread distribution of cases of Mediterranean Fever in the garrison, no corps or barracks as a rule being exempt, but there are occasional outbursts of epidemicity which do not show any uniform preference for particular months of the year. For instance, the outbreak at Imtarfa in 1899 occurred from May to July, while the epidemic at Floriana in 1903 was at its height from August to October. Table VI, p. 34, shows that in the naval hospital at Bighi the ratio of patients eventually developing the disease constantly differs in all four quarters of the year.

4. In epidemic years the outbreak is usually confined to single units, while nothing more than ordinary prevalence is observed amongst the rest of the garrison. It is important to remember, in this connection, that milk is not a Government supply, and the milk for the different

units and officers' messes was obtained from very various sources, each unit and mess making its own arrangements.

5. One of the most striking statistical facts is that, in proportion to strength, the liability of the military officer to attack is over three times as great as in the case of the man, and very much the same is noted in the navy also. It is also important to observe that soldiers' wives are attacked in the proportion of two to one as compared with the men. Officers and women are more in the way of consuming milk in various forms than the men. The civil statistics do not show the same liability to attack on the part of the female, the relative numbers of notifications being about equal for the two sexes.

6. The disappearance of Mediterranean and simple continued fevers from Gibraltar in the course of the last 20 years has been stated by Horrocks to be coincident with the cessation of importation of goats from Malta and the probable exodus of infected goats from the Rock.

7. During 1906 there has been a remarkable diminution in the prevalence of Mediterranean Fever in both fleet and garrison, and it is significant that, so far as the civil notifications can be relied upon, no corresponding reduction is observed, up to the end of September, as regards the civil population, which are the latest figures in our possession. In both services this has closely followed the preventive measures relating to milk detailed in other parts of this report. So far as the Navy is concerned, the only alteration in preventive measures has been the increased attention paid to the control of the milk supply. The isolation of Mediterranean Fever cases has been carried out for some years past at Bighi. In the garrison, besides the general substitution of condensed for goats' milk, isolation of Mediterranean Fever cases was simultaneously carried out.

8. It is important to observe that isolation of cases was not in itself sufficient in previous years to prevent the frequent occurrence of Mediterranean Fever amongst patients in other parts of the hospital at Bighi.

(ii.) *Direct Evidence.*—1. The history of the s.s. "Joshua Nicholson," detailed in another part of the Report, practically demonstrates the possibility of the infection of man by the ingestion of goats' milk.

2. Enquiries into the milk histories of service patients this year have elicited the fact that, in the large majority of the cases, a direct relation with the use of fresh milk could be traced. The evidence obtained from investigations as to the relative prevalence of Mediterranean Fever amongst the consumers of condensed milk chiefly, and of fresh milk chiefly, have uniformly shown that the chances of infection are much greater in the case of the latter.

3. The examinations of goats made in connection with barracks and other establishments in which Mediterranean Fever was prevalent

have invariably shown the presence of infected goats, and that the milk of some contained the *Micrococcus melitensis.*

4. Dr. Critien's paper gives a number of cases in which Mediterranean Fever occurred in the civil population among consumers of goats' milk which was found on examination to contain the specific organism. A good piece of negative evidence is provided by Dr. Caruana Scicluna's facts relating to the Institute of the Good Shepherd at Balzan, to the effect that when the milk supply is uniformly obtained from healthy goats, no cases of Mediterranean Fever occur.

Contact.—Inoculation is a certain way of conveying the disease, as witness the laboratory cases in which it has followed wounds with infected articles. It is, therefore, probable that the disease is sometimes acquired through infected milk, or less often urine, coming in contact with breaches of the surface. Infection of goats and of goatherds is likely to occur in this way. Contact with infected material was also the most probable explanation of the infection of the three R.A.M.C. laboratory attendants, one in 1905 and two in 1906.

As far as the evidence obtained during the investigation of individual cases in barracks is concerned, although the possibility of contact cannot always be excluded, the balance of evidence goes to show that it is probably not a frequent factor. Very few of the men who have come under observation as "contacts" with cases of the disease have had to be subsequently admitted for it, and for the few there are other possible explanations.

One or two instances have come under observation in which persons with no previous history of fever have occupied the same bed as a Mediterranean Fever patient, for weeks together, without contracting the disease by so doing.

The large prevalence of Mediterranean Fever among attendants on the sick would at first sight appear to indicate that contact was a factor of primary importance, but the cessation of cases amongst sick attendants, in both naval and military hospitals in Malta, since the milk change is rather suggestive that contact cannot be a very potent factor. Away from Malta, sick attendants on Mediterranean Fever cases do not contract the disease in the performance of their duties, as, for example, on the hospital ship "Maine," and in Home military and naval hospitals. Nor are any instances known, in Home hospitals, of patients admitted for other ailments contracting the disease through being treated in the same ward with Mediterranean Fever cases. Evidence tending in the same direction is derived from a study of the occupations of the Sick Berth Staff attacked at Bighi.

The possibility of Mediterranean Fever being contracted during sexual intercourse requires mention. The disease has often been

observed to supervene in cases admitted for venereal disease. The *Micrococcus melitensis* has been recovered from the urine of prostitutes and from vaginal swabbings. It is, however, probably not a frequent path of infection, and milk diet in hospital is likely to have been the source of a considerable proportion of these cases in the past.

Biting Insects.—The experimental evidence obtained in 1906 does not lend support to the view that the disease is commonly transmitted to man by the bite of infected mosquitoes. The monkeys experimented upon were each bitten by batches of mosquitoes, which in turn had been separately fed on grossly infected guinea-pigs. That the mosquitoes contained infected blood was determined by the recovery of the *Micrococcus melitensis* from ingested blood and from mosquito droppings. Yet, although the conditions were infinitely more favourable for the conveyance of infection to the monkey than could ever possibly obtain for the infection of human beings by mosquitoes containing blood drawn from a human source, only one very doubtful instance of infection occurred among the 14 monkeys concerning which accurate data are available. This is in marked contrast to the almost universal success which attended the milk feeding experiments.

The epidemiological evidence also tells against the mosquito propagation theory, as will be seen from the following considerations:—

1. The evidence obtained from the investigations of individual cases in 1906 is altogether negative. Answers to questions as to whether a man has or has not been bitten by mosquitoes are possibly of no great value, as many men pay little heed to mosquito bites. From patients who had contracted the disease during the earlier months of the year the answer was commonly in the negative, whereas affirmative replies were frequent in the warmer months.

2. The disease continues to prevail at seasons of the year when mosquitoes are few, or when they seem to be almost absent, as in the earlier months of 1906.

3. There was considerable prevalence of Mediterranean Fever in the garrison during the first six months of 1906, but a large reduction in prevalence occurred in July, August, and September, when mosquitoes were abundant.

4. Cases have come under observation in which the most careful attention was paid to the use of mosquito nets, yet the disease was contracted.

5. The use of mosquito curtains in the Mediterranean Fever wards at Bighi for years did not prevent the occurrence of many cases in the other wards of that hospital.

6. Officers, who as a class make free use of mosquito nets, are three

times more liable to contract the disease than the men, who are not protected from mosquito bites at all.

7. The Camerata married quarters are surrounded by a dense civil population, amongst whom there must be abundant opportunities for mosquitoes to become infected, yet the incidence of Mediterranean Fever is generally light.

8. A study of the cases that have developed in the Royal Naval Hospital at Bighi, where isolation has been the rule for some years, shows that propinquity to the potential sources of infection—*i.e.*, the Mediterranean Fever wards—has had little influence in determining the contraction of the disease, notwithstanding the presence of abundance of mosquitoes.

9. The evidence given in the naval part of this Report, in connection with docking, also argues against mosquito infection.

Sand-flies were much more troublesome than mosquitoes in 1906 in some of the barrack blocks and married quarters. They have a very general distribution in Malta and they suck blood voraciously, their bite causing intense irritation, which leads to scratching, and, especially with children, to the formation of nasty-looking sores. If biting insects can convey the disease, the sand-fly has advantages over the mosquito, as it bites more freely, and nets afford little or no protection. There is no evidence that the disease has been conveyed by it. The same is true of another blood-sucking fly, the *Stomoxys calcitrans*, although it is known to be able to act as the host of the *Micrococcus melitensis* for a few days.

Bugs and fleas cannot be at present incriminated.

FLIES.—The possibility of flies being carriers of the specific micrococci must be remembered. In goat houses and goat pens flies are often present in enormous numbers. They swarm in milking places which are sodden with goats' milk and urine. They are often abundant in latrines, where they may come in contact with infected urine. Arguing from the analogy of enteric fever, the fly may alight on infected matter, and may carry the cocci on its body or legs to food, etc. The fly as a carrier of the disease is discussed in connection with some cases in the West Kent Regiment.

DUST.—The disease has been conveyed to healthy animals by dust, artificially contaminated. The fact that *Micrococcus melitensis* is readily killed by exposure to sunlight, and the rapid dilution that must occur when the dust is blowing about under natural conditions, are against dust being a common factor in the spread of the disease. Localised gross contaminations are possible, as, for example, the surfaces of places in regular use for goat milking, which must necessarily become sodden with milk and urine, and here the possibilities

will be in direct proportion greater. The possibility will be even greater in milking places and goat pens shaded from the sun. The evidence obtained in 1906 is against dust infection.

Drain Emanations.—Hughes favoured the view that emanations from drains and sewers played a large part in the direct causation of this fever. Davies discussed this point at some length (Part IV of the Commission Reports), and we can only add that we have been unable to gather any evidence supporting Hughes' views during our investigation of the cases occurring amongst the troops in 1906.

Foods.—No evidence against foods other than milk has as yet been obtained. It has been found that the *Micrococcus melitensis* retains its virulence in locally-made cheese. Local butter and local cheese are not used by the troops. We have only come across two instances in which local (Gozo) cheese had been eaten.

Water.—*Micrococcus melitensis* has never been found in water under natural conditions. The scattered distribution of the cases of Mediterranean Fever in barracks, which is the rule, is against water-borne infection.

iii. Recommendations.

As the goat is more than probably the primary source of the disease in the vast majority of cases, if not in all cases, and as goats' milk is the common vehicle for the *Micrococcus melitensis*, it follows that preventive measures, to be effective, must be based on sound regulations, framed with a view to stamping out the disease in the goats. In the meanwhile, there should be a vigorous control both of the goat traffic and of milk supplies.

It will not be an easy matter, perhaps, to alter customs which have been in use for many generations, and it may prove impossible to do so otherwise than gradually. There will be much prejudice to be overcome, and even much active opposition on the part of some sections of the public, especially those who make their living by keeping goats and vending milk, and also on the part of many consumers, as it is a common argument in Malta that a large section of the people prefer to have the goats brought to their doors and there milked. Public opinion will have to be educated in the matter, and it will probably be necessary to combine the *suaviter in modo* with the *fortiter in re*.

The local authorities, both civil and belonging to the two services, are fully aware of the facts that goats are sources of the disease, and that infection of milk is both widespread and common.

The Civil measures which are in operation are as follows:—

1. *Notification.*—All cases of fever lasting more than seven days

are to be notified. We have good reasons for believing that many cases of Mediterranean Fever either do not come under observation at all, or that the medical practitioners fail to notify. This requires improvement, and, perhaps, the payment of a small fee.

2. *Blood Examinations.*—The Public Health Department undertake the examination of samples of blood from civil cases, but although facilities have been offered to civil practitioners during the last two years, they have only been made use of in less than a quarter of the cases notified as suffering from Mediterranean Fever. There is also room for further improvement here.

3. *Sanitary Inspection.*—A sanitary inspector visits each case notified and makes special inquiries into, amongst other things, the kind of milk used and its sources, occupation, the sanitary conditions of the premises, contact with previous cases, etc. Inspections of the sanitary conditions of goat houses, etc., also come within the scope of their duties. Some special work is being done by the medical officers of health, as will be observed from Dr. Critien's paper.

4. *Segregation of Goats.*—It is in contemplation to make arrangements for the segregation of reacting goats as a general practice, and to kill off those that are found to be persistently infected, and in both cases the question of compensating the owners is in point.

The Service measures in operation are :—

1. *Notification.*—This may be regarded as complete.

2. *Milk.*—Condensed milk has been substituted for goats' milk in both military and naval hospitals. This change had been decided on just before the goat-herds' strike in May in the case of the military hospitals, and it dates from the period of that strike in the case of barracks. We had begun the campaign against the use of goats' milk in barracks and hospitals at the end of April.

3. *Goats.*—The entry of goats into barracks has been prohibited, as well as their being kept in the neighbourhood of barracks.

4. *Instructions to Soldiers and Married Families.*—Soldiers and the married soldiers' families have been warned as to the dangers of using goats' milk, and they are being taught that it is very necessary to guard against making use of goats' milk, or of articles made from it, outside their barracks or quarters.

Measures for stamping out the disease resolve themselves into measures for dealing with infected goats, and measures directed to control of the milk supplies. Measures of this kind have already been dealt with in the Reports to the Commission by Horrocks and Kennedy (*vide* Part IV, p. 82).

These observers recommended :—

1. That the perambulation of goats through the streets of the towns in Malta should be strictly forbidden.

2. That all goats showing a persistent blood reaction should be

destroyed, as examinations of milk alone cannot be taken as a basis of action, owing to the excretion of the *Micrococcus melitensis* being intermittent in character.

3. That the milking of goats should be done in their pens or in some central depôt.

4. That the goats should be penned as far as possible from human habitations.

5. That the milk should be transmitted to the towns in sealed cans.

6. That promiscuous micturition should be prohibited, and a penalty imposed on offenders.

The second of these measures implies, of course, the organisation of arrangements for the examination of goats and for the segregation of those found to be infected for further observation. It would be, perhaps, beyond the limits of practicability to undertake the systematic observation of all the goats in Malta. It would mean making from 15,000 to 20,000 milk or serum agglutination tests every few weeks. The practical measure, at all events to begin with, would appear to be the examination of all goats suspected to be infected, and occasional test examinations of herds.

We recommend, in addition, that all goats intended for exportation should be examined before shipment, say a fortnight before and again a day or two before being shipped, and no reacting goat should be allowed to be put on board.

We do not agree that goats should be milked in their pens, but we strongly support the formation of milk depôts in all important centres, which, if not Government institutions, should be under the control and strict supervision of the Public Health Department. We are in complete agreement with the rest of the foregoing recommendations.

The existing sanitary laws would appear to give sufficient powers to the authorities, both in regard to the control of the goats and of the sale of milk to the public, if they are only enforced and carried out both in spirit and in letter.

The Malta Sanitary Ordinance, No. III of 1904, Chapter II, Section V, Articles 79 to 100, already provides:—

1. That all purveyors of milk shall be licensed, and that the licence shall only be granted on condition that the dairy is well built, fitted with impervious floors, well ventilated, and otherwise sanitary (Articles 79 and 80).

2. Dairies are to be kept clean and periodically limewashed (Article 81).

3. Goats and cows are to be notified and inspected (Articles 82 and 83); and cows are to be branded on the horns and hoofs (Article 82).

4. Sickness is to be at once notified and the animal inspected. If the disease from which the animal is suffering be declared infectious,

the person authorised to inspect the animal shall forbid the sale of the milk, and shall apply other preventive measures (Article 84).

5. No milking operations or any handling of milk shall be made by anyone who may be suffering from, or recently convalescent from, any infectious disease, or who lives in the same house with such cases (Article 86). Certain diseases are specified, but Mediterranean Fever is not named among them.

6. Living places are not to be used for storing milk, and cow sheds shall not communicate with the place in which milk is kept or sold, but shall be separated therefrom by an open space (Articles 87 and 88).

7. The cleanliness and method of cleansing of utensils and vessels used for the preservation and sale of milk is also legislated for (Articles 89 and 90).

8. No one shall expose or keep for sale the milk of animals stricken with any disease held to be capable of altering the nature of the milk (Article 91, *b*).

9. It is part of the duty of the Government veterinary surgeon to watch over the hygiene of stalls, and the state of health of animals destined for the production of milk. (Ordinance dealing with the organisation of the Public Health Department, Chapter VIII, Article 40, *e*.)

10. There is a Council of Health which advises the Government on all matters affecting hygiene and the public health. It has on it one naval and two military representatives.

The relative importance of goats and cows, as sources of milk supply in Malta, did not receive due consideration when this Ordinance was framed, as in many of the provisions the word "cow" alone is used, and it is only by implication that they can be held to apply to goats.

Actual observations of the conditions obtaining in the places where goats are penned or housed, which were made in the course of our work, show that the regulations in regard to housing are more honoured in the breach than in the observance. The Ordinance is yet young, and it has to be remembered that the enforcement of the law means very radical alterations in the conditions previously prevailing. It was an attempt to enforce the provision of impervious flooring and limewashing in specific instances that led to the goat-herds' strike. The goat-herds are an uneducated class, and much prejudiced against what they consider unnecessary innovations. It will probably take a long time before these prejudices are overcome, and the only alternative appears to be dairies or depôts belonging to Government, or large owners, and in the latter case under Government control.

To sum up, we recommend as follows :—

A. *Measures relating to Goats.*

1. The perambulation of goats through the streets should be strictly forbidden.

2. The branding of goats on the hoofs should be carried out, as in the case of cows.

3. The goats should be penned or housed as far as possible from human habitations.

4. Examination of goats suspected to be infected.

5. Examination of all goats intended for exportation before shipment.

6. Segregation of reacting goats for observation.

7. Destruction of goats showing persistent infection.

8. Compensation to owners on two scales: (*a*) while their goats are segregated, and (*b*) for goats destroyed.

B. *Measures relating to Milk Supplies.*

1. The establishment of large dairies or depôts under Government control or supervision.

2. The transmission of the milk in sealed cans to proper dairies in the towns.

C. *Other Measures relating to the Civil Population.*

1. More strict notification.

2. Efforts should be made to extend the practice of having blood examinations made in cases of fever.

3. Impress on sanitary inspectors the importance of their milk enquiries.

4. As recommended by Horrocks and Kennedy, educate the people by leaflets telling of the importance of preserving some degree of sanitation in their dwellings, the dangers of infected milk, need for milk sterilisation, etc.

5. Promiscuous micturition in the streets and roads should be prohibited, and a penalty imposed on offenders.

6. Latrine accommodation should be provided for workmen employed in building operations.

D. *Measures specially applicable to the Services.*

1. With regard to the garrison, the isolation of Mediterranean Fever cases should be continued.

2. The entry of goats into barracks or other Government places should be strictly prohibited; and they should not be allowed to be housed, nor should resting-places be permitted to be established in the neighbourhood of such places.

3. Pending the possibility of obtaining *absolutely safe* milk, the use of goats' milk, or its products, should be absolutely forbidden in any hospital, barracks, ship, or other Government establishment. Sterilisation cannot be trusted.

4. The use of condensed or other forms of preserved milk should be continued in hospitals and barracks, including messes and other regimental institutes.

5. Continue the warnings to soldiers and to soldiers' families as to making use of goats' or cows' milk outside barracks or quarters.

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